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GERMAN TECHNICAL AID TO JAPAN - MIS

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WAR DEPARTMENT
MILITARY INTELLIGENCE DIVISION
WASHINGTON

(P)

GERMAN TECHNICAL AID TO JAPAN

Prepared by Military Intelligence Service

FOR THE ASSISTANT CHIEF OF STAFF, G-2:

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Foreword

This report constitutes a study of German technical assistance to the Japanese war effort. The study is based on all available intelligence material drawn from all sources.

It should be realized, however, that information on certain aspects of German-Japanese technical liaison is incomplete. In particular, is this true with reference to blockade running between Europe and the Far East.

With regard to documents, plans and blueprints obtained by Japanese representatives in Germany, it is possible that such material was sent to the Far East by courier traffic through the various Japanese Embassies in Europe and by Japanese diplomatic couriers returning to Japan through Siberia. Because of this contingency, it must be realized that the study is not of necessity complete.

The study applies to air and land armaments, electronics, manufacturing processes, raw and manufactured materials, and interchange of technical personnel. It does not cover naval equipment and naval radar.

It is suggested that this report indicates a field which should be a matter of immediate investigation by Allied intelligence teams due to operate in the Japanese Empire

31 August 1945

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German Technical Aid to Japan

Summary

Under terms of the Economic Agreement of January 1943 and the Manufacturing Rights Agreement of March 1944, Japan acquired in Germany raw materials, military equipment, manufactured goods, manufacturing plans and drawings, and technical assistance. Transfer to Japan of acquired materiel was effected by blockade runners--both surface vessel and submarine--courier and parcel post, and rail communication through Siberia. Originally restricted in interest to German equipment in operational use, by a January 1945 Hitler order Japan was allowed access to all German equipment, whether experimental or fully operational.

Japan's interests primarily were directed toward German equipment, the acquisition of which would improve the Empire's defenses against air attack. In that connection jet-and rocket-propelled aircraft, equipment to improve high-altitude performance of conventional aircraft, early warning radar and anti-aircraft defensive weapons were strongly featured in Japanese negotiations.

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Jet-and rocket-propelled aircraft:

Because of their high speed and high-altitude performance, and possibly because their employment would offer some relief to an acute aviation gasoline position, Japan made strenuous efforts to acquire all the benefits of German jet-and rocket-propulsion aircraft techniques. The results of Japan's efforts in this direction may be summarized as follows:

a. ME-163: It is believed that there is in Japan sufficient information on the ME-163 to allow the building of at least experimental models of that aircraft. In mid-1944 drawings and plant layouts for plants to manufacture the chemical fuels used in the ME-163 were handed to Japanese representatives in Germany. It is probable that some or all of those drawings arrived in the Far East; in addition, a large amount of detailed information on the large-scale production of those chemical fuels was made available to the Japanese in Germany. There is evidence to suggest that production of chemical rocket fuels may have been in progress at the Japan Nitrogen Company plant at Konan, Korea.

b. ME-262: It is not believed that adequate information for production of the ME-262 arrived in the Far East. There is evidence, however, that some information on

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the experimental model of the ME-262 may have arrived in Japan.

c. Other jet-propelled aircraft: There is little indication that Japan showed any particular interest in other German jet-propelled aircraft although the Japanese did acquire information on the HE-162 single-jet fighter; a smaller amount of information on the AR-234 was similarly acquired. There is no evidence that Japan intended production of either of those aircraft.

d. Turbo-jet units: Development of a turbo-jet unit was underway in Japan as far back as 1941; the evidence suggests that little success was achieved. Great interest was shown in German turbo-jet units, but it is believed that little information on German turbo-jet units was carried to the Far East by blockade runners.

Metallurgical problems apparently handicapped Japanese development in this field. Krupp developed two special steel alloys for use in German turbo-jet units. Manufacturing rights for those alloys were acquired by Japan, but at a date too late to allow shipment to the Far East of full information on their production and machining.

e. Campini engine-driven jet: Japan has experimented with development of a jet unit based on the Campini

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principle. There is evidence of negotiations between Japanese representatives in Italy and Campini concerning an aircraft powered by Campini type units; negotiations were concluded, however, at a date too late to allow Japan to acquire full benefits from such a contract. Campini-type units, using an 80 hp engine, have been found at Yokosuka; they were to power a modification of the Baka.

f. The V-1: The V-1 was a weapon which appealed to the Japanese. The Argus propulsion tube in particular was the subject of detailed investigation by Japanese representatives in Germany. There is evidence to suggest that Japan intended the use of a piloted version of the V-1 as a suicide weapon.

g. Technicians: German jet technicians were to be transferred to the Far East to supervise production there of German jet propelled aircraft; in addition, Japanese technicians were to be trained in Germany and then returned to the Far East. It is believed that no fully trained technicians, either German or German-trained Japanese, arrived in Japan.

Conventional aircraft:

During the period 1941-43, when surface blockade running was possible, Japan purchased and shipped to the Far East various prototype German aircraft. When submarine blockade running later restricted cargo space, Japan turned

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to the purchase of plans and blueprints, and of prototypes of small aircraft parts. In those later stages her inquiries were directed towards aircraft types with improved high-altitude performance. There is no evidende to indicate that plans or blueprints of the more recent types of German aircraft arrived in the Far East.

Aircraft engines, the installation of which would improve the high altitude performance of existing Japanese aircraft, also were of great interest to Japan. However, prototypes of only early type German aircraft engines arrived in the Far East; some of those engines have been manufactured under license in Japan. Sample equipment of German power-boost systems was purchased, but shipment to the Far East probably was not possible. Some information on those boost systems, which improve the altitude performance of internal combustion engines, probably reached Tokyo.

Large quantities of German aircraft guns and ammunition were purchased by Japan. Samples of smaller caliber guns and ammunition were shipped to the Far East; some of those samples have been found on Japanese aircraft. Attempts to obtain guns and ammunition of 30 mm caliber and above were severely restricted by lack of cargo space. Some samples of those larger caliber guns may have arrived

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in the Far East.

Aircraft rocket armament also greatly interested Japanese representatives in Germany. Sample equipment of a number of types of rocket armament was purchased; it is believed that none of the samples arrived in Japan.

Japan negotiated for German pressurized cabins for high-altitude flying and for associated electrical aircraft equipment. Samples of an early type pressurized cabin are believed to have arrived in Japan. Extensive purchases of German high-level bomb sights were mainly negatived by a lack of shipping space; samples of early type high-level sights, however, did arrive in the Far East.

Reports on the HS-293 radio-controlled, rocket-propelled glider bomb were prepared in Germany for dispatch to Tokyo; sample equipment, however, did not reach the Far East. There is little evidence that any information on the newer types of German guided missiles was passed to the Far East. The evidence suggests that Japanese representatives in Germany knew little or nothing about those newer guided missiles.

<u>Land armaments and ammunition:</u>

Japanese interest in German land armaments has covered a very wide field of equipment embracing infantry

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weapons, guns, howitzers, rocket projectors, coast defense and naval guns, armored vehicles, gun controls and predictor gear. In many instances manufacturing rights were acquired by Japan, whose representatives in Germany also had opportunity to examine manufacturing processes.

Electronics:

Japan's interest in acquiring technical assistance from Germany in respect to radar and radio equipment generally was exceeded only by her interest in German aircraft. The Japanese apparently looked to Germany for general technical assistance in electronic development, but were not as interested in acquiring manufacturing plans and drawings as was the case in other directions. The Germans delivered to the Japanese prototypes of their own equipment and tubes, but at least up to the final stages of the war, did so only in respect to material known already to be in Allied hands. The Japanese, through Germany, also acquired captured specimens of Allied electronic equipment. Various Japanese radar and redio technicians were permitted to study German equipment; German electronic technicians were shipped to Japan, but are reported to have had no success in their mission to the Japanese electronics industry.

Toward the end of the war the Germans were more

willing to divulge complete information on radar developments. Generally it may be assumed that Japanese technicians in Germany were fully informed on all recent German research in the high-frequency field.

German technicians with whom the Japanese officials worked in Germany have expressed the opinion that through German liaison the Japanese obtained a very thorough gounding in electronics research and production. That opinion is based on the assumption--in many instances a very doubtful assumption--that the information collected in Germany reached Japan.

Optical equipment:

Optical glass has been the subject of a close association between Japan and Germany over a period of years. In the days of surface blockade running, extensive purchases of optical glass were made through ordinary commercial channels; concurrently, during 1942-43, the Japanese Army was buying and shipping optical glass for specific military purposes. With the end of surface blockade running in the spring of 1943, the familiar pattern of Japanese purchasing policy on a new basis was reproduced in respect to optical material. Through 1944 the Army and Navy took charge to an increasing degree, although Mitsubishi continued to negotiate for, and

collect data on, glass manufacturing techniques. Particularly suitable for submarine cargo, optical glass retained a high priority for transport to the Far East.

Manufacturing processes; raw and special manufactured materials:

The acquisition by Japan of various German manufacturing rights also involved the granting of tachnical assistance for the purpose of establishing German manufacturing processed in Japan. The Japanese thereby acquired a number of important German manufacturing processes, including the I.G. Farben hydrogenation process, the Henschel aircraft mass production system, and techniques for the manufacture of wooden aircraft.

As a result of these negotiations Japan acquired a number of patents, the legality of which is a subject worthy of consideration.

Prior to the outbreak of the Russo-German war, Japan acquired considerable quantities of materials in Europe and shipped them to the Far East through Siberia. Thereafter, Japan was forced to rely upon surface blockade runners for movement of material to the Far East. With the end of that channel of supply, certain raw and manufactured materials of the highest priority continued to move from Germany to the Far East by submarine right up to the end of the war. Mercury,

special steels, aluminum, lead, platinum, industrial diamonds and ball bearings all were purchased and shipped to the Far East in varying quantities.

Japan acquired, in varying degrees of detail, information regarding a number of synthetic products specially developed in Germany. In most cases simple descriptions of the product probably were sufficient to allow production of the material in Japan; for more complicated material, methods of production were described or demonstrated to the Japanese. Included in those special synthetic products were materials used in the manufacture and transportation of concentrated hydrogen peroxide, and special materials and adhesives used in the manufacture of wooden aircraft.

Conclusion:

From the Japanese point of view, the opening up to Japan of modern German war equipment and manufacturing techniques unfortunately coincided with severe restrictions in blockade running between Europe and the Far East. As a result, Japan was not able adequately to benefit from Germany's more open attitude toward negotiations. Sample German equipment in the Far East mainly is restricted to items which were in operational use in the period 1941-43. Japanese

knowledge of more recent German developments generally is restricted to descriptive information, supplemented in some cases by manufacturing drawings and blueprints. Available evidence suggests that Japan had not progressed far in the development of more recent German war equipment and manufacturing techniques. Plans for intensive development of German equipment in the Far East, under supervision of fully trained German or Japanese technicians, were negatived to a considerable extent by a lack of shipping space.

Introduction

a. Economic Agreements of January 1943:

Technical liaison between Germany and Japan reciprocated under the German-Japanese Economic Agreement of January 1943; a separate Economic Agreement between Japan and Italy was concluded at the same time. Both Agreements were in general terms and provided for the mutual exchange of raw materials, military equipment, manufactured goods, technical assistance and drawings, an exchange which had been in practical execution for some time past. The Economic Agreements were to have a life span equal to that of the political Tripartite Pact of 27 September 1940.

At the time of the signing of the German-Japanese Agreement, public comment stressed very justly the relative wealth and reciprocal possibilities of mutual assistance; that is, on the one hand, the great assets of raw materials in the hands of the Japanese and required by Germany, and, on the other hand, the benefits accruing to Japan from the highly efficient German war machine and industrial techniques.

Broadly speaking, the subjects of exchange between Japan and its European Allies have been:

(1) German and Italian material and techniaal

development,

and

(ii) German intelligence on Allied technical developments.

In general, techniques and scientific research had progressed further in Germany than in Japan, a fact of which the Japanese have taken full advantage. Available evidence suggests that the Japanese were free to inquire about any field of development which interested them; in general, German willingness to impart information appears to have been greater in respect to Allied materiel than it was in respect to German equipment.

In the early stages of execution of the Agreements, it would appear that the Germans, rather than volunteer information, awaited specific Japanese inquiry. In fact, with items of special interest and significande in the nature of original weapons and developments, data was not provided to the Japanese except after protracted negotiations and, on occasion, was subject to direct order of approval of Hitler.

b. Manufacturing Rights Agreement:

In March 1944, as a corollary to the Economic Agreement, Japan concluded with Germany an agreement couched

in general terms covering the exchange of manufacturing rights. That Agreement planned an application of lend-lease principles with no arrangements for immediate payment by either side until after the war. It was intended that as her contribution, Japan should supply many raw materials to Germany; in return, Japan would obtain from Germany materials, processes, manufacturing rights and technical assistance.

The March 1944 Agreement, which marked a turning point in the history of Japanese purchases from Germany, was necessitated by the virtual ending of surface blockade-running. Because of the limited cargo space in submarines which thereafter carried out blockade running, it was necessary to concentrate on the exchange of plans, blueprints, manufacturing rights and small prototype equipment, rather than the actual purchase of machines, weapons and materiel.

The conclusion of the March 1944 Agreement resulted in the sale to Japan of many processes and manufacturing rights. Originally--by order of Hitler--Japanese interests in Germany were restricted to such equipment as was in operational use. In January 1945, however, Hitler reversed his decision and ordered that Japan be allowed access to all materiel and processes in Germany, even such as were still in the experimental and development stage.

c. Patent Rights Agreement:

In December 1944, Germany proposed a second agreement intended to cover the exchange of inventions of importance to the war. That agreement was to go into effect one month after signature and was not to be abrogated "until 6 months after the conclusion of the mutual conduct of the war of the two contracting parties." The Agreement appears to have been disigned to protect the secrecy of inventions, knowledge, experience, methods and instructions regarding production, and to prevent confiscation of patents. It was thus complementary to the Manufacturing Rights Agreement. The Patent Rights Agreement was never signed, apparently because of an unwillingness on the part of Japan which delayed negotiations until the end of the European war.

d. Channels of liaison:

In Germany technical liaison was channeled through the offices of the Japanese Military and Naval Attachès in Berlin and technical assistants working on the staffs of those two Attachês. In Japan a joint Army-Navy Technical Application Committee was founded, the function of which was the coordination for both the Japanese Army and Navy of all technical material obtained from Germany. In spite of the assistance of that committee, however, there apparently

was some duplication of inquiry by the two services.

Paralleling the Tokyo committee and cooperating with the Japanese Attachè in Berlin, the Germans set up a "Committee on the Provisions of Manufacturing Rights to Japan." That committee was composed of representatives of the Foreign Office, Treasury, War Production Ministries and the National Defense Economic Office, and worked under the chairmanship of the Reichsgruppe Industry. The committee received all Japanese proposals as to the acquisition of manufacturing rights for military material, although the Japanese could carry out prior negotiations with German officials or firms. Final authority rested with the High Command of the OKW. The Japanese service Attachès in Berlin, however, could negotiate contracts direct with German firms. For ordinary commercial non-war material needs the Japanese were free to make direct contact with German industry.

To assist the Japanese in negotiations for German Air Force equipment, a special office--the Office of the Special Representative for Japan--had the task of advising and assisting the Japanese in their requests and negotiations for German air equipment, including air defense equipment.

In all cases involving blockade runners, either

surface or underwater vessels, the trans-shipment to the Far East of documents and materiel purchased by Japanese representatives in Germany was the responsibility of the German Navy.

e. Channels of supply:

The main channels of supply whereby information and materiel were exchanged between Europe and the Far East were:

(i) Surface blockade runners and submarines.

(ii) Mail by courier and parcel post, presumably through diplomatic channels.

(iii) Rail communication through Siberia.

The volume of traffic carried by courier mail and parcel post through diplomatic channels cannot be determined. Quantity traffic by rail across Siberia was closed with the opening of the Russo-German war, but, nevertheless, passage of personnel still continued after that date.

In addition, the use of long-range aircraft was fully considered. One Italian aircraft in 1941 made a round-trip flight to Tokyo. From 1941 on negotiations were carried out to open an air route between Europe and the Far East. Germany planned that such flights should be made by the northern route; Japan, on the other hand, to avoid

infringement of Soviet neutrality, opposed such a route and recommended in its place the utilization of a southern route. Because of this difference of opinion, and because of a lack of long-range German transport aircraft, no such transport flights were carried out.

In the period 1941-1943 a large volume of two-way shipment was carried out by surface blockade-runners. The cessation of surface blockade running and the subsequent loss of French Atlantic coast ports to submarine blockade runners greatly restricted interchange of material and information during 1944-1945. Although some submarines are known to have successfully made the trip between Europe and the Far East, the limited cargo space available restricted the material sent to Japan to blueprints, plans, small prototype equipment and special materials carrying the highest priority; a small number of technical personnel also were transported to the Far East by U-boat.

f. Japan's benefits from the interchange:

It must not be overlooked that while the prosecution of the war was the primary objective of the exchanges to both Germany and Japan, Japan has greatly benefited from the exchanges. Her technical knowledge has been considerably strengthened and she has coincidentally acquired mater-

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ial, technical processes and manufacturing rights which, unless appropriate counter-measures are taken, will be of the greatest benefit to her peace-time industry. Particularly does this apply to the numerous patents and processes granted to Japan by Germany, although in certain instances such patents and processes may not have been Germany's to give.

g. Technical aid acquired by Japan in Europe

Of the information obtained by Japan from Germany, emphasis appears to have been placed on improved defensive strategy, applied particularly to the direction of high-performance aircraft, warning devices and coast and ground defenses. Considered broadly, the information obtained by Japan appears to have fallen in the following categories, listed according to priority of Japanese interest:

(i) Aircraft

(ii) Electronics

(iii) Naval equipment

(iv) Land armament and ammunition

(v) Optical equipment

(vi) Manufacturing processes

(vii) Special raw materials, manufactured materials and technical literature.

To assist in the development and production in Japan of equipment obtained in Germany, and to supervise Japanese production of war materiel, there was an interchange of technical personnel between the two countries. German technical and production experts were shipped to work in the Far East; Japanese personnel were sent to Germany to train in German techniques and production methods and in some cases were able to return to the Far East after completion of such training.

The body of the study consists of the progress and results of Japanese negotiations for German equipment and manufacturing techniques. Information concerning the equipment for which negotiations were carried out is contained in a series of Tabs attached as appendices to the study.

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SECTION I

JET- AND ROCKET-PROPELLED AIRCRAFT: JET AND ROCKET POWER UNITS AND FUELS

Note: Performance and descriptive data for the aircraft, power units, and fuels covered in Section I will be found in TAB D.

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SECTION I

JET- AND ROCKET-PROPELLED AIRCRAFT: JET AND ROCKET POWER UNITS AND FUELS

Introduction:

Captured documents indicate that, as far back as 1941, the Japanese were considering jet-propulsion as a means of powered flight, and that by early 1942 they had developed the theory of a turbo-jet power unit, had the basic design of such a unit already completed and had evolved the design of an aircraft---of the flying-wing type---powered by two turbo-jet units. The non-appearance of such aircraft and power units in the Far Eastern war suggests that development from theory to production was retarded by practical difficulties. This is substantiated by a captured Japanese technician's notebook, dated March 44, which stated that the problems encountered with the turbo-jet power unit were "poor cooling; turbine blades fly off". In developing a turbo-jet unit, the Japanese apparently encountered the same problems as those which confronted the Germans, namely, the production of metals capable of withstanding the high temperatures involved, and, at the same time, capable of being

easily machined and worked to the required form for turbine-blades.

It is perhaps natural, therefore, that the Japanese should have attempted to profit to the utmost from German design and productive and operational experience in the field of turbo-jet aircraft, by obtaining blueprints, plans and sample equipment of turbo-jet units--and of aircraft powered by such units--which the Germans had developed to a stage of practical production and operation.

Limitations of altitude performance, together with relatively poor radar equipment, undoubtedly made the Japanese realize the vulnerability of the Empire to high-altitude daylight bombing. A possible answer lay in the fast-climbing German ME-163 rocket-propelled interceptor; thus the Japanese developed an acute interest in that aircraft. An aircraft using chemical fuel probably was a new technique to the Japanese, although they earlier had obtained information about German chemically-fuelled assisted take-off rockets.

Jet- and rocket-propelled aircraft probably had one other aspect which stimulated Japanese interest. Since the jet aircraft used diesel-type fuel and the

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rocket aircraft chemical fuel, their large-scale development and employment would have offered some relief to a high-octane fuel economy which threatened to become serious when the Empire was isolated from the oil-rich southern possessions.

Japanese jet- and rocket-propulsion research:

Information available from various sources bears considerable evidence of the trend of Japanese development in the fields of jet- and rocket-propulsion. That evidence suggests that three main lines of development were being pursued:

(i) liquid rocket propulsion,

(ii) turbo-jet propulsion, and

(iii) engine-jet propulsion.

In addition, solid rocket propulsion was developed to an operational stage, as is evidenced by the Baka.

In the fields of turbo-jet propulsion research, a captured document reports on the results of experiments during the period April 41 - March 42 as carried out at the Naval Air Technical Depot, presumably at Yokosuka. That document, stated to be the sixth report on the subject, includes a theoretical treatment of pressure and

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temperature distribution in a turbo-jet unit together with an analysis of the thermodynamics of such a unit. The report concludes with a schematic diagram of a turbo-jet unit, together with a tailless aircraft powered by two such units.

A notebook dated 16 March 44 captured in the Philippines contains notes on various experimental jet and rocket units. Included in those notes is a very elementary diagram of a turbo-jet unit which was stated to be under research at the Air Technical Depot (again presumably Yokosuka) and stated that the defects in that unit were poor cooling and the fact that the turbine-blades flew off.

Japanese research on engine-driven jet units apparently leaned heavily on Campini's research and development in that field. A document dated 13 January 42, captured on Saipan, is a report on the theoretical and experimental data of a Campini type unit as a power unit for aircraft. The document is a discussion of the Campini method of jet-propulsion and its possible improvement. Although no work with actual installations was mentioned, the belief was expressed that, by introducing a combustion chamber at the rear of the blower, an

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improvement of thrust could be obtained. The document contains detailed calculations and graphs of the propulsion efficiency of a Campini type unit and suggests that, at the time of the report, the Japanese had a metallurgical problem in that they apparently had not developed metals able to stand up to the high temperatures of a jet-propulsion system. The report also includes a sketch of an aircraft powered by two Campini units driven by a common 2,000 hp engine mounted in the fuselage. Those experiments also apparently were being carried out at Yokosuka.

The notebook captured in the Philippines had drawings of two Campini type units. One, reportedly invented by a Lt. Col. Tanegashima, incorporated a combustion chamber at the rear of the air blower. The other, powered by a low-power internal combustion engine had, according to the sketch, no such combustion chamber and was intended only as an auxiliary power unit. It was stated in the notebook that the unit was to be mounted below the bomb bay of a twin-engined bomber when high speed at low altitude was required. Yet another captured document refers to a Campini type jet unit using a 2,000 hp internal combustion engine.

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The evidence suggests that Japanese development of Campini type units was directed to the development of two types of unit. One, powered by a low horsepower engine, was to be used as an auxiliary power unit, probably for twin-engined aircraft; the other, using a high powered engine, was to be used as a straight power unit.

There is little evidence of Japanese developments in the field of liquid-rocket propulsion. However, a P/W who appears to be reliable and very knowledgeable, referred in interrogation to "Shu Sui", a small piloted interceptor, fired from a ramp mounted on a turntable and capable of climbing to 10,000 meters in 3 minutes. The P/W stated that the propulsion unit of this interceptor was not, to his belief, of the solid rocket type as used in the Baka and that the interceptor, which has a single fin and rudder, was a modified German design. The very high rate of climb suggests the use of a liquid-rocket propulsion unit, and if, as the P/W suggested, it was based on German design, the unit possibly may have been of the Walter type, using hydrogen peroxide for fuel.

<u>Progress of negotiations</u>:

Initial Japanese interest in German jet technique was in respect to assisted take-off rockets as used on the

JU-88 bomber. In early September 1943, Japanese representatives in Berlin requested information concerning those rockets, and, as of that date, appeared to be under the impression that the rockets used a solid powder propellant, rather than concentrated hydrogen peroxide and a catalyst. In the following November it was intended to dispatch specimen rockets to Japan at the earliest opportunity. Information on the nature and properties of T-Stoff and the catalyst (Z-Stoff--potassium permanganate) was obtained and negotiations for manufacturing rights, presumably for the assisted take-off rockets, were undertaken.

At the beginning of 1944, the GAF High Command first revealed to the Japanese in Berlin the secret jet- and rocket-propelled fighters. The Japanese lost no time in availing themselves of this willingness on the part of the Germans to divulge information on jet and rocket aircraft. An official request for information was made by Japanese representatives in Berlin, and, in March 44, Hitler and Göring decided that the information should be made available to Japan.

According to a letter from Milch to Göring, dated 1 April 44, discussion between Japanese and German representatives led to the formulation of Japanese requests

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for (i) Messerschmitt jet technicians to be sent to Japan, (ii) the training of Japanese technicians in Germany, and (iii) the purchase by Japan of manufacturing rights for the construction under license of the ME-163 B and ME-262 A-1. In making those requests the Japanese were availing themselves of the terms of a Hitler order that Japan must be given extensive information concerning future German developments, and of the fact that, in the preceding January, Göring had expressed agreement in principle with the idea of close Japanese-German collaboration as regards the latest types of German aircraft and their manufacture. The Japanese requests were placed before Göring for a decision. By the beginning of April 44, descriptions, survey sketches and illustrations of the ME-163 B and ME-262 A-1 already had been turned over to Japanese representatives in Germany, although those aircraft still were only under test.

Initially, there appears to have been duplication of inquiry by the Japanese Army and Navy. The Germans commented on this state of affairs, pointing out that they had no intention of making agreements separately with the two services and that it would seem advisable for one service to take complete charge of the negotiations.

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Apparently as a result of discussions it was decided that the Navy, which had principally undertaken research in jet propulsion technique and had made considerable progress, was to assume responsibility for negotiations with Germany in relation to techniques, securing of production plans, and the training and procuring of technicians, but it was proposed that there should be joint Army/Navy research. In line with that decision, an Army/Navy agreement was concluded for the purpose of coordinating research on rocket aircraft.

In spite of this understanding, the Army maintained direct contact with Germany, particularly on the ME-163. The bulk of technical material, however, was collated by Naval personnel or by the Army and Navy jointly.

The specific interests of the two services in various types of jet and rocket propulsion aircraft are difficult to define and the evidence is somewhat contradictory. The Navy apparently was primarily responsible for developing the general techniques in Japan, while both services were to produce the aircraft. It is probable that both services were attempting to produce both jet- and rocket-propelled aircraft.

Around April 44 negotiations were under way to allow the Japanese to purchase manufacturing rights for the Walter propulsion unit, the ME-163 fuselage, the turbo-jet propulsion unit (presumably the Junkers model, although attempts were being made also to obtain the BMW type) and, in addition, two complete ME-163 aircraft; the negotiations also were to provide the Japanese with all the results of testing and experience of the German manufacturing companies. In May, the Germans agreed to release manufacturing rights for the ME-262 fuselage, but at that time negotiations were not successfully concluded, possibly because considerable modification of the ME-262 was necessary as a result of trial flights. Plans for the aircraft were to be made available to the Japanese in the fall.

Captured OKL archives indicate that the GAF High Command then suffered a change of heart with regard to release of plans and details of its jet- and rocket-propelled aircraft. Although both Hitler and Göring apparently had made verbal decisions early in 1944 that the Japanese should be exposed to jet and rocket propulsion techniques, a letter of mid-June stated that, on orders from Göring, no data was to leave the appropriate German

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aircraft factories, even if a contract for manufacturing rights had been concluded, until receipt of special instructions from the German Air Ministry. It was not until July that orders were issued for the preparation and handing over to the Japanese representatives in Germany of sets of blueprints and drawings for the manufacture of the aircraft, propulsion units and chemical fuels. The sets of blueprints and drawings were to be sent to Japan as individual sets on different U-boats. On 22 July, Göring approved the granting of licenses to Japan for the delivery of 1 ME-163 and 1 ME-262 as sample aircraft.

Security considerations still apparently were of the greatest concern to the Germans. A 21 August letter stated that the release of the sample ME-163 and ME-262, although approved, was not to become effective until the OKL had taken all necessary safety measures to preserve the security of the equipment. Those measures included making certain that, in emergency, the entire shipment of parts could be destroyed immediately so that none should fall into enemy hands.

On 28 August the OKL was notified once again that the Japanese had requested the release of one ME-163 and one ME-262 to be transported to the Far East by a U-boat

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already in Germany. Japanese hopes suffered a setback at this time, as Hitler refused the release of the aircraft. A 16 September letter clarified this refusal, stating that it was only temporary and was made because the aircraft were not fully developed from a technical standpoint. At the same time, this order authorized the continuance of the surrender to Japan of manufacturing rights and the necessary plans for the aircraft and their power units. By late September, the OKL had decided that in view of the limited transport space available, deliveries of sample aircraft to Japan would have to be dropped, but that necessary plans and sample power units, together with some of the individual parts of the power units which were especially difficult to manufacture, should be released for transportation to the Far East, probably during October. Hitler reversed his decision early in October and ordered that deliveries were to be carried out without limitation. By this time, however, transportation was no longer possible and it seems fairly clear that sample equipment of the aircraft and their power units never reached the Far East.

Japanese negotiations with Messerschmitt regarding jet- and rocket-propelled aircraft:

Messerschmitt officials have provided the following information on Japanese negotiations with respect to that company's jet- and rocket-propelled aircraft.

At the beginning of 1944 the Japanese suggested the manufacture under license in Japan of the ME-163 and ME-262; production in the Far East was to be carried out under the supervision of German engineers. In addition, Messerschmitt specialists were to go to Japan to supervise development there of Messerschmitt high-speed aircraft. In those negotiations the lead was taken by the Japanese Navy.

It became clear during the negotiations that the Japanese could not build the ME-163 and ME-262 without compulsory modifications; they therefore required specialists who would supervise manufacture in accordance with those modifications. The modifications were necessary because of Japanese ignorance of German production methods, because of a lack of skilled workers, and because of a lack in Japan of certain special materials, among which thin sheet steel was outstanding. That material was used

for the nose of the ME-262; since Japanese sheet steel manufacturing processes were incapable of producing sheet steel of the necessary thinness and resilience, the nose of the Japanese produced ME-262 was to be made of duralumin. The reason for Japanese limitations in the field of thin sheet steel was not a lack of raw materials, but ignorance of production methods and a lack of skilled supervisory personnel.

Apparently it seemed essential to the Japanese that they be independent in the production of every component for both aircraft. They therefore bought manufacturing licenses not only for the fuselages and wings of the two aircraft, but also for production of all components. In particular did they show an interest in the plywood process involving the strengthening of wood by the moulding of veneer strips glued with Tego film. A license for that process was acquired and Japanese experts received training in the necessary techniques.

The impressions of the Messerschmitt officials with regard to the negotiations with Japan can be summarized as follows:

a. It was obvious that the Japanese intended production of the ME-262, after several major changes

in construction had been effected;

b. Production was intended on a limited scale only;

c. The Japanese apparently did not intend to build the ME-163, relevant documents being needed for study purposes only;

d. The intensity with which the Japanese demanded a license for the plywood process indicated the importance which they placed on plywood development;

e. Under the most favorable conditions, the earliest date for mass production of the ME-262 must be estimated at $1\frac{1}{3}$ years after arrival of the necessary documents in the Far East.

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<u>The ME-163</u>:

Immediately on receipt of information about jet and rocket development in Germany, the Japanese in Germany began to show the greatest interest in the ME-163. In mid-May Japanese naval representatives in Berlin were negotiating for complete production plans for the ME-163, and for the transfer to Japan of technicians fully familiar with design and production of the aircraft and its propulsion unit. By mid-August a considerable amount of detailed material on the ME-163 possibly had arrived in Tokyo.

A captured file of Electrochemische Werke, München--manufacturers of liquid-rocket chemical fuels--contains documents which indicate a strong probability that plans for the Walter HWK 109-509 power unit of the ME-163 arrived in Japan. Contained in that file is a letter of 9 August 1944, from Walter's Berlin office, which quoted a 13 July order from the German Air Ministry to manufacturers of jet and rocket-aircraft and power units that delivery of drawings should take place, regardless of the signing of agreements covering manufacturing rights. Walter's letter continued with the statement that the Walter factory at Kiel already had delivered to

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the Japanese in Berlin all drawings, including ten sets of plans and a complete plan of the works. It is probable that the drawings and plans were handed over to Japanese representatives in Berlin on 13 July, the date on which those representatives received all drawings in connection with the manufacture of liquid rocket chemical fuels. It is probable that those plans were shipped from Europe during the next month. Since they were in ten-copy, at least one set of drawings for the Walter HWK 109-509 must have arrived in the Far East by the end of the year.

Further information was given to the Japanese in regard to the use of beech plywood for the main wing skin, and on thicknesses of the skin at various points along the wing. Information on the adhesives used for the wooden parts of the aircraft, and concerning the process for manufacturing main wing spars and laminated wing surfaces, and the repair of wings also was provided. In September-October the Japanese representatives first learned some detail of the ME-163 C.

Still further detailed information on the ME-163 and of the handling of its chemical fuels, including the base installations necessary, was requested by the Japanese in November. Those requests, in conjunction with

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the detailed information already supplied by the Germans, suggest that, although not in possession of blueprints, Tokyo nevertheless was attempting to build at least an experimental copy of the ME-163 on the basis of the information available, and anticipated operations by ME-163's at some future date. Further evidence of anticipated development of the ME-163 in Japan is provided by evidence of a Japanese request for information on ME-163 tactics and German methods of ground control.

General Kessler, who was captured en route to Tokyo, where he was to become German Air Attaché, stated, under interrogation, that the first Japanese ME-163, or a copy of that aircraft, had made a powered test-flight in December 44. That information, which was quite unexpected, was received from the German Ambassador in Tokyo.

In January 45, Japanese interest appears to have been centered on the ME-163 C.* Strenuous efforts were made for dispatch to Japan of the techniques of the JU-248, together with sketches of the aircraft showing the principal parts and points of difference from earlier types. Arrangements were also made for the transfer of

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*This aircraft also was referred to as the JU-248, JU (ME)-263 and 8-263.

German technicians to the Far East, first priority being given to a Messerschmitt assembly foreman, with an engineer familiar with plans for the JU-248 as second priority.

It seems clear that Japan appreciated the possibilities of the ME-163 as a defensive weapon against B-29 attacks, where its high rate of climb would be of the greatest value. While its limited endurance was disadvantageous, against this must be weighted the fact that many of Japan's primary targets for air attack were in coastal areas. With limited radar warning, a fast-climbing fighter was essential. Also the use of an aircraft powered by chemical fuels would help alleviate a tight aviation fuel situation. It is probable, therefore, that strenuous efforts were made to reproduce the ME-163 in Japan. Although no sample aircraft, and probably no complete set of blueprints for the aircraft arrived in the Far East, the information available probably was sufficient to allow of attempted construction of the aircraft. Apparently, however, the experiments were not successfully completed. No positive identification of the ME-163 was reported by combat crews operating over Japan, nor were any identified on photographic cover.

A Japanese aircraft technician captured in the Philippines made reference to a small, fast-climbing

interceptor to which the name "Shu Sui" had been given by the Japanese. He stated that the propulsion unit of that aircraft, a specimen of which he had seen at the Yokosuka experimental base, was of a rocket type, but not of the solid rocket type used in the Baka. The rate of climb which he attributed to "Shu Sui" suggested a liquid rocket propulsion unit.

Preliminary reports of Allied occupation of Yokosuka made reference to the presence there of bat-like flying wings. According to U.S. Navy reports of a preliminary survey of the Yokosuka Technical Air Arsenal, an unspecified number of "Shu Sui" liquid rocket jet fighters modeled after the ME-163 had been found in the flight test stage.

No discussion of the possibility of successful development of the ME-163 in Japan can, however, be divorced from consideration of successful development of the associated chemical fuels. It would have benefited the Japanese little to reach the production stage with the ME-163, if they were unable to master the problems of large-scale manufacture, transportation and storage of the chemical fuels. Those problems were many and complex, as is fully evident from German experience in this field.

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Liquid rocket chemical fuels:*

The Japanese representatives in Germany apparently first became aware of the employment of concentrated hydrogen peroxide (T-Stoff) in connection with the use by the GAF of that material in conjunction with permanganate (Z-Stoff) for rocket-assisted take-off. The Japanese purchased samples of such assisted take-off equipment and, in conjunction with that purchase, became cognizant of T- and Z-Stoff.

It was not until the Japanese became exposed to the ME-163 that they received information as to the employment of concentrated hydrogen peroxide as a fuel for that aircraft. There is evidence to suggest, however, that production of hydrogen peroxide may already at that time have been under way in Japan, although the Japanese are thought to have been experiencing difficulties in its production.

In the spring of 1944 Japanese representatives in Germany entered into negotiations with the appropriate German firms for purchase of manufacturing rights for B- , C- and T-Stoff. Agreements were not signed until

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*The nature, characteristics and manufacture of liquid rocket chemical fuels are briefly discussed in TAB D.

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14 December 44. However, at an early stage in the negotiations, orders were issued by the German Air Ministry to the effect that the handing-over to the Japanese of blueprints and plans was not to await the signing of an agreement, but was to take place forthwith.

A captured file of Chemische Fabrik Gersthofen contains a series of letters and documents which indicate that the Japanese representatives in Germany on 13 July 44 received all the drawings and plans for B- , C- and T-Stoff manufacturing installations. It presumably was those plans which were discussed by Nakai and German scientists on the occasion of Nakai's visit on 24 July to Hollriegelskreuth, the German hydrogen peroxide pilot plant. During that visit the German scientists showed to Nakai, and discussed with him, the operating peroxide concentration plant, discussed the apparatus of the plant stage by stage in full detail--including the materials used in construction and special requirements of each individual piece of apparatus--and repeatedly went over the manufacturing process and techniques in conjunction with the plans supplied to the Japanese. The letter reporting on Nakai's 24 July visit made it clear that Nakai's inspection and discussions were only in respect of the concentration

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plant, and did not cover production by the electrolysis method of the original 35% hydrogen peroxide from which concentration to 80-85% peroxide (T-Stoff) was carried out. It should be pointed out, however, that available evidence indicates that the Japanese already knew how to manufacture low-concentrate peroxide--a standard commercial product--and that their main concern was with the concentration process. The Riedel-Schering electrolysis process for manufacture of 30-35% commercial peroxide was purchased by Japanese interests several years before the war. Specifically, the captured file contained the following information:

(1) A 29 April 44 letter date lined Hollreigelskreuth which referred to a discussion at the Air Ministry between RLM representatives and representatives of Messerschmitt, Junkers, BMW, Walter and Elektrochemische Werke München, apparently held on 28 April. The letter referred to a Hitler order according to which Japan was to have access to the newest GAF developments. Under terms of that order all plans for Japan were to be ready by 10 June 44, and were to include drawings and descriptions for the concentration plants for B- and C-Stoff manufacture.

(ii) A 31 July 44 letter from Kojima to Elektrochemische Werke München, which made reference to Nakai's visit--presumably that on the 24th--and offered thanks for the descriptions and plans. Replying to that letter on 2 August, EWM expressed their hopes that the plans given to Nakai--which were stated to be necessary for production--would clarify unspecified questions which previously had been raised.

(iii) A 20 September 44 letter from Walter, Berlin which referred to the negotiations in progress with the Japanese, and mentioned specifically:

(a) First discussions were held at the Air Ministry on 22 April;

(b) A letter from the German Air Ministry dated 13 July, which stated that plans were to be handed over to the Japanese whether or not an agreement had been concluded;

(c) Copies of appropriate agreements were to be handed to Japanese representatives in Berlin on 28 August;

(d) Plans were given to Harke and Nakai at the German Air Ministry on 13 July 44. Walter

held the original receipts for those plans and included copies thereof with the 20 September letter.

The receipts referred to under item (d) above, are signed by Nakai and dated 13 July. They refer to material received in connection with agreements MZ-2 (with EWM for T-Stoff) and MZ-3 (with Chemische Fabrik Gersthofen for B- and C-Stoff). In them Nakai acknowledges receipt, in duplicate, of the following:

(a) Description of the T-Stoff process;

(b) Description of apparatus for the T-Stoff concentration plant;

(c) A list of drawings for the T-Stoff concentration plant (21 drawings for the B- and C-Stoff plants).

The file also contains a draft of the agreement signed by the Japanese for manufacturing rights for B- and C-Stoff, and, as an annex to that agreement, lists the material Japan is to receive upon its signing. That material includes a description of the process, consisting of some 40 pages (apparently from content matter the lengthy document which appears at the end of the captured file) and, in addition, 21 drawings for B- and C-Stoff

plants. The description and drawings refer to a plant with a capacity of 300 tons per month of B-Stoff and corresponding quantities of C-Stoff. It presumably was a duplicate set of those 21 drawings which was received by Nakai on 13 July. The drawings are as follows:

1. Layout
2. Reaction tower
3. Erection of NH_3 evaporator
4. NH_3 - extraction column
5. NH_3 - rotation evaporator
6. Reflux cooler for NH_3 column
7. NH_3 condenser
8. NH_3 recooler
9. Evaporator for salt evaporator
10. Rotation evaporator for salt evaporator
11. Salt evaporator pump
12. Porcelain funnel
13. Fractionation column
14. Group salt evaporator - general drawing
15. Preconcentration
16. Scheme for preconcentration
17. Rotation evaporator for preconcentration
18. Return condenser for preconcentration

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19. Final concentration

20. Scheme for concentration

21. Rotation evaporator for final concentration

Those documents clearly indicate that by 13 July Japanese representatives in Berlin were in possession of descriptions of the manufacturing process and appropriate drawings of the plant and various apparatus for the manufacture of chemical fuels. If this is so, then it is more than likely that those plans and descriptions were shipped from Europe at the earliest opportunity. As the material handed to Nakai on 13 July was in duplicate, it seems logical to assume that complete sets of the material were carried on at least two U-boats. It thus appears probable that at least one set of descriptions of the manufacturing process and drawings of the necessary plant for chemical fuels production arrived in the Far East.

In October, Japanese representatives in Germany visited a T-Stoff manufacturing plant in Germany and obtained detailed information regarding its manufacture. During the following month they made a seven-day personal study of the new German B-Stoff plant at Gersthofen and obtained information on (i) the plant used at the factory, (ii) production schedules and (iii) detailed measurements

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of the apparatus. This information was supplemented by study of the apparatus, flow sheets, details of the tanks employed in the apparatus, the raw materials needed for the process, and details of the method of operation with particular reference to pressures and temperatures, and investigations of the method of titration and the method of production of C-Stoff, the analysis of that material, and the number of staff required for production.

The D-86 catalyst used in connection with T- and C-Stoff also was the subject of Japanese investigation in August. Investigation covered the weights of the various raw materials required and its method of production in the stick form in which it was used in Germany. A supplementary investigation in September, covered further points about the method of manufacturing D-86 which had been gathered since the earlier study. The Japanese are known to have had contacts with Dr. Demant, the chemical engineer in charge of all rocket experiments under the direct control of the German Air Ministry.

Documentary evidence indicates that plans for the German experimental plants were handed to Japanese representatives in Germany in July 44, and that, before the end of that month, Nakai had visited the German pilot

plant and had discussed manufacturing techniques and plant installation in some detail. It seems probable that some of those plans and of the information gathered by Nakai were included in the cargoes of one or more of the U-boats which may have left Europe late in the summer of 1944 and arrived in the Far East by the end of the year. If such be the case, it seems possible that that information may have been adequate to enable the Japanese to build and operate plants for the large-scale manufacture of liquid rocket chemical fuels.

One other problem faced the Germans with regard to liquid rocket chemical fuels--that of storage and transportation. There is ample evidence that much experimentation was necessary before those problems satisfactorily could be met. Germany eventually arrived at the employment of pure aluminum containers for T-Stoff and of mild steel containers lined with Oppanol for B- and C-Stoff. German experience in this direction was made available to the Japanese in Germany.

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The ME-262:

It was early in 1944 that Japanese representatives in Germany apparently first became aware of German development of the ME-262. While it appears that the Japanese were fully aware of the ME-262, nevertheless, their primary interest initially lay in the ME-163. This may have been a result of the features of the ME-163 which made it an aircraft particularly suitable for use in defense of Japan against air attack. Alternatively, however, it may be that Japan believed that success was imminent with its own development of turbo-jet units and of aircraft powered by such units. Documentary evidence indicates that such development had been in progress in the Far East since at least 1941. The Japanese representatives in Germany, however, continued to obtain information about the ME-262, and negotiations for manufacturing rights for the ME-163 were paralleled by similar negotiations in respect to the ME-262 and German turbo-jet units.

The 1 April 44 letter from Milch to Göring, referring to Hitler and Göring decisions with regard to German-Japanese collaboration, indicated close Japanese interest in the ME-262 A-1. The letter stated that, in accordance with Hitler's order, descriptions, survey

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sketches and illustrations of the A-1 sub-type already had been turned over to the Japanese. It is believed that those sketches and descriptive material were successfully transported to Japan, arriving there by the fall of 1944.

Japanese negotiations for manufacturing rights for the ME-262 and its power unit followed a pattern identical with those for the ME-163. In June 44, the aircraft and industrial manufacturing rights were released to Japan, the delivery, however, being subject to special orders from Göring. During that month, Japanese representatives visited ME-262 production centers, where Bringewald--in charge of ME-262 production in Germany--lectured them on the construction and special features of the aircraft. According to Bringewald, the Japanese showed particular interest in the use of wood for certain parts of the ME-262. In mid-July, Messerschmitt was ordered to prepare sets of traceable drawings and blueprints to be handed over to the Japanese for transportation to the Far East; later in the month Göring approved the handing over to Japan of a sample ME-262. In late August, however, Hitler reversed his original decision and refused the release of a sample ME-262 to Japan.

Meantime, preparation and delivery of necessary blueprints and plans proceeded, although delivery to the Japanese continued to be subject to orders from Göring. It was not until October 44 that Hitler released the ME-262. The necessary contract with Messerschmitt for sale to Japan of manufacturing rights finally was signed in December 44.

One of Messerschmitt's principal planning engineers has stated that he and four other Messerschmitt employees were the only ones who knew of a plant to transmit to Japan complete technical and production plans for the ME-262. Plans were delivered, in October 44, to Dr. Thun--head of Messerschmitt's foreign export branch--at Jettingen; a Japanese representative was present on that occasion. According to German Air Ministry records, sample parts and accessories for the ME-262 scheduled for delivery to Japan were still held by Messerschmitt in mid-September 44; their delivery to the Far East, therefore, is very unlikely. This suggests that the only drawings to reach Japan concerning the ME-262 were the preliminary survey sketches and illustrations of the A-1 sub-type which may have arrived in the fall of 1944.

There is evidence that the Japanese Army intended to go into large-scale manufacture of the ME-262. Under

terms of the Army's contract with Messerschmitt, the principal work of von Chlingensperg, a Messerschmitt technician detailed for transfer to Japan, was to be that of directing the design of short-range fighters and long-range bombers at Kawasaki; as far as possible, the Army also desired to have him direct the conversion, presumably of existing aircraft factories, to the manufacture of the ME-262.

In late October the Japanese in Berlin advised the Germans that only the Army was planning production of the ME-262 and requested investigation for the Army of two production plans for that aircraft, one for 100 aircraft a month, the other for 500. Meantime, the Japanese were making arrangements for the transfer to Japan of Bringewald, a Messerschmitt technician who was to direct manufacture of the ME-262 in the Far East. At that time it appears that the Army was putting the greatest emphasis on the improvement of the ME-262 fuselage and the Jumo-004 propulsion unit. Nevertheless, first of all, attempts were being made rapidly to perfect the ME-163, principally as a means of high altitude defense.

It is evident that Japan received little detailed information on the construction of the ME-262. However,

German tactical employment and ground organization of ME-262 fighter units were closely studied by Japanese representatives and full information on performance characteristics and tactics was obtained.

Bringewald, the Messerschmitt civilian technician, and Ruf, a Messerschmitt expert on procurement of industrial machinery, left for Japan in the U-234 and were captured when that U-boat surrendered to Allied forces. They carried with them blueprints and plans necessary for the setting up in Japan of factories adequate for the production of 500 ME-262's a month. They calculated that it would take at least 1½ years after their arrival before the first ME-262 would come off the production line and that it would require 3,000,000 man-hours to get the factory ready for production. They further stated that two Japanese engineers in Germany had given information that the Japanese were working on a turbo-jet unit but were meeting with continuous difficulties. It was the opinion of Bringewald and Ruf that the Japanese were not capable of building the ME-262 without receiving complete specifications and technical supervision from German specialists. They were convinced that the Japanese did not have sufficient data and information to build the

ME-262, since no parts of the aircraft or its propulsion units had been sent to Japan, nor was there in Japan any German specialist who could provide the necessary assistance.

It seems possible, however, that the Japanese, if they had been able to develop a turbo-jet unit to the operational stage, might have built an aircraft which, although not a copy of the ME-262, was based on that aircraft. The success or otherwise of such experiments obviously depended on the successful development of a turbo-jet unit. That, in turn, undoubtedly was greatly influenced by the extent of the information available in Japan on the design and construction of German turbo-jet units, on the difficulties encountered by Germany in their development and of the methods by which such difficulties were overcome. While only the Jumo-004 was used in the ME-262, the BMW-003 basically is of similar design, and information available in Japan on either of these turbo-jet units was a potential source of assistance to the Japanese in their own experiments.

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The AR-234 and HE-162:

There is no evidence that the Japanese entered into negotiations for the purchase of manufacturing rights for the AR-234 or the HE-162, nor is there any indication that plans or blueprints for the aircraft were handed to Japanese representatives in Germany. The evidence suggests that the Japanese did not contemplate production of either of these aircraft.

The JU-287:

The JU-287, a high-speed bomber powered by six turbo-jet units arranged in groups of three under each wing, was still in the development stage at the end of the war and only brief test flights had been carried out. In a 5 January 45 letter, the German Air Ministry notified Otani that, if so desired, manufacturing rights for the JU-287 could be made available to Japan. There is no evidence to suggest any interest by the Japanese in this high-speed bomber.

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Turbo-jet units:

Japanese interest in German turbo-jet units developed as part and parcel of the interest in the ME-262. As has been noted above, by 1 April 44 the Japanese had, in accordance with an order by Hitler, received general descriptions, survey sketches and illustrations of the ME-163 B and ME-262 A-1. It must be assumed that included in the material on the ME-262 was information concerning its turbo-jet units. In any event, the 1 April letter from Milch to Göring included the Jumo-004 B-1 among the subject matter for cooperation in the field of jet-propulsion and rocket aircraft development.

The Japanese thereupon entered into negotiations with the Junkers firm for purchase of manufacturing rights for the Jumo-004; parallel negotiations were carried on for the BMW-003. Those negotiations followed the pattern of those for the ME-163 and ME-262, in that they were subject to a change of heart on the part of Hitler, which delayed delivery of sample equipment to the Japanese in Germany until October 44. However, in mid-July, BMW and Junkers were instructed to prepare drawings and blueprints of their respective turbo-jet units, as transportation to Japan was expected shortly to be available; one

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set of drawings in each case was to be made available to the Japanese in Berlin by the middle of July. There is no positive evidence that any blueprints of turbo-jet units did arrive in the Far East. Agreements for the purchase of manufacturing rights were not signed until December 44. However, it is possible that some blueprints were handed over prior to the conclusion of negotiations--as was the case with the Walter power unit--and may have been carried to Japan by submarine.

Because of a reported shortage of technical personnel, the Junkers firm apparently was unable to supply a skilled technician to supervise production in Japan of the Jumo-004, and, presumably, the BMW-003. It was for this reason that Schomerus--a Messerschmitt technician lost on a German submarine early in 1945--was detailed to collect information on production of turbo-jet units and act in a supervisory capacity in the Far East.

Japanese technicians in Germany carried on extensive research in methods of manufacturing turbo-jet units. Among the points discussed by them with BMW and Junkers were large-scale production methods for turbine and compressor blades, measures for prevention of damage due to vibration of those blades, and German methods of

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cooling turbine-blades.

It would appear that, without a basic understanding of the principles of turbo-jet propulsion, the scant information received by the Japanese would not be adequate for the construction of a turbo-jet unit based on German designs. However, in assessing the value of the information obtained in Germany, it must be remembered that as far back as 1941 the Japanese had, at least on paper, designed a turbo-jet unit, had carried out theoretical calculations of temperature and pressure distribution in such a unit, and had designed a tailless aircraft to be powered by two such units. Furthermore, the captured March 44 notebook indicated that Japanese development of turbo-jet units had progressed to the stage where experimental production was in hand. According to that notebook the Japanese were encountering considerable difficulties in their researches, a fact which is corroborated by statements made by Bringewald and Ruf, the Messerschmitt technicians. It is possible that the information obtained in Germany may have provided sufficient information to enable the Japanese to overcome the difficulties encountered in their own development of turbo-jet units. U.S. Navy cables report the discovery at the Yokosuka

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Technical Air Arsenal of one coaxial turbo-jet unit assembled and ready for test and of many components in the machining stage.

According to the March 1944 notebook, one of the main problems which Japanese development was encountering was that of the turbine-blades flying off the turbine disc; in addition, problems of cooling also had been experienced. Cooling and turbine-blades were two factors which the Germans also had to overcome in their successful development of turbo-jet units. The turbine-blade problem was met by the development by Krupp of two special high-duty steel alloys, Tinidur and Chromadur. Japanese representatives in Germany became aware of the existence and use of these alloys through their negotiations for manufacturing rights for the Jumo-004. The extent to which information on these alloys arrived in Japan appears, therefore, to be of considerable importance in determining the ability of Japan successfully to develop turbo-jet units.

According to a German P/W, in the latter half of September 44 plans for the Riedel starter, used in turbo-jet units, were handed over to Japanese representatives in Germany, on orders of the German Air Ministry. The Japanese had no direct contact with the Riedel firm, transfer of the starter plans being made through Junkers.

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Special materials for turbine-blades:

a. Tinidur and Chromadur high-duty steel alloys: A file of the firm of Friedrich Krupp, Essen, indicates the progress of negotiations between that firm and the Japanese Navy for the purchase by the latter of manufacturing rights for two special high duty steel alloys--tinidur and chromadur--and the machining processes necessary for the production of turbine-blades from such alloys.

Negotiations with Krupp began in mid-1944. Krupp initially was extremely reticent to release the required data; it was not until 12 February 45 that the necessary agreement between Krupp and the Japanese representatives finally was signed. In the meantime, however, the Japanese had acquired considerable information on the composition and manufacture of the alloys in question, through visits to Krupp, Essen by Tarutani, of the Japanese Navy, and Schomerus, a Messerschmitt technician who had been selected to go to Japan to assist in production there of Messerschmitt jet-propelled aircraft. Tarutani and Schomerus visited Krupp, Essen in October 44, Schomerus being authorized to acquire information on the production of tinidur and chromadur. Although Tarutani

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and Schomerus were not specialists in the field of high-duty alloys, they nevertheless apparently were given step-by-step outlines of the production procedure.

The importance of tinidur and chromadur in the production of turbine-blades is emphasized over and over again in correspondence, between Krupp and the German Government, wherein Krupp is justifying the fee demanded by them for the sale of manufacturing rights. In that correspondence it is stated that, without tinidur and chromadur, the Japanese could expect a 50-100% loss in development stages.

On 17 June 44, a representative of Junkers visited Krupp to inform the latter that Junkers was preparing to turn over to the Japanese manufacturing rights for the Junkers turbo-jet unit. That unit employed tinidur for the construction of parts taking "the maximum strain" and the Junkers representative stated that it was that firm's intention to inform the Japanese not only of the basic data for tinidur, but also of its designation and source of supply. In reporting this to the OKW, Krupp stated that they were not interested in passing on to the Japanese any further manufacturing methods for steel. They had requested Junkers not to go beyond giving to the

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Japanese the basic data for the alloy, so that the Japanese would be required to initiate with Krupp inquiries and negotiations for manufacturing rights and processing techniques. To that the Junkers representative agreed.

Apparently this was done and the Japanese realized that the production of tinidur was essential to satisfactory development in Japan of the Jumo-004 or a turbo-jet unit based on that design. On 4 October, Krupp, Essen, was visited by Schomerus and, on the following day, by Tarutani of the staff of the Japanese Naval Attaché in Berlin. Both those gentlemen visited Krupp for the purpose of viewing the manufacture there of turbine-blades for the Jumo-004. The visits apparently were somewhat unexpected. Schomerus appeared at Krupp without previous announcement, for the avowed purpose of meeting there with Tarutani to collect information concerning manufacture of turbine-blades, including preparation of the raw materials. Tarutani appeared at Essen on the 5th on an officially authorized visit.

Schomerus and Tarutani began their visit with a conference between those gentlemen and representatives of Krupp. According to a report on that conference

contained in the Krupp file, the firm's representatives pointed out to Schomerus and Tarutani that all information gathered as a result of their visit to Essen must be treated with the strictest confidence and passed on to the Japanese only upon explicit instructions from the German Air Ministry. Moreover, instruction was given with the understanding that the entire matter was to be settled subsequently by contractual agreement. After those facts had been recorded, technical instruction was begun. Subsequent correspondence indicates that Krupp shortly, after the visit, forwarded to Schomerus materiel memoranda concerning tinidur and chromadur.

Schomerus and Tarutani both were given a general insight into the production of solid and hollow turbine-blades. Various phases of the work were discussed in detail and the process of manufacture was inspected. Schomerus was given a detailed description of the various methods of producing the alloys by smelting, but this procedure, and discussion thereof, was dispensed with in the case of Tarutani. Both were given the prescribed procedure for the machining of solid blades, and discussed that procedure with the Krupp representatives; similarly both were shown the procedure for rolling tinidur sheet

metal. Schomerus, in addition, was shown the manufacture of solid blades, was given opportunity to note down details of the process and to sketch tools and equipment, and was given sample material at various stages of turbine-blade production. Schomerus, furthermore, was authorized to take photographs. Tarutani was supplied with materiel memoranda for the alloys, together with exact analysis data.

In that data the percentage composition of tinidur and chromadur was described as follows:

	Tinidur	Chromadur
Carbon	0.1 - 0.15	less than 0.12
Silicon	0.3 - 0.6	0.3 - 0.6
Manganese	0.2 - 0.4	17.5 - 18.5
Chrome	14.5 - 15.5	11.5 - 12.5
Nickel	29 - 31	Nil
Vanadium	Nil	0.6 - 0.7
Titanium	Nil	0.18 - 0.23

Instruction was provided as to the adjustment of the proportion of titanium to carbon in order to prevent the accumulation of carbide in tinidur. Other data given for the two alloys included (i) tensile strength and elastic limit at various temperatures, (ii) creep limit, (iii) treatment temperatures for forging, annealing and thermic

treatment, (iv) coefficient of expansion, and (v) modulus of elasticity.

An outline of the step-by-step production of solid blades of tinidur given to the Japanese covered dimensions of the metal at varying stages and temperatures of operation, where processing was carried out at other than atmospheric temperature. A brief step-by-step procedure for the manufacture of hollow blades from tinidur also was given.

In late October, Junkers notified Krupp that a directive had been issued to place at the disposal of the Japanese Government manufacturing rights and data for the Jumo-004 B, manufacture of which called for turbine-blades of tinidur. Under the terms of the March 1944 agreement between the German and Japanese Governments, it was necessary to make available to the Japanese Navy all patents on associated manufacturing materials and experiences, which must, therefore, include the tinidur turbine-blades. Those experiences must cover composition, production, shaping and use of the blades in question. Junkers, therefore, requested Krupp to get in touch with the appropriate authorities to legalize the information Junkers was required to furnish the Japanese.

Negotiations proceeded apace during November and were handled on the Japanese side by Tarutani and Capt. Iki. The Japanese were anxious that Krupp representatives should go to Berlin, whereas Krupp regarded it as essential that certain specialists should be present at the negotiations, a fact which made it necessary for the Japanese to visit Essen.

In early December, Krupp learned that the Japanese wished to conclude an agreement for the production of turbine-blades not only from tinidur but also from chromadur, and, in addition, required agreements covering the production of both alloys. That new development apparently had arisen as a result of a conference between Reichsminister Speer and Ambassador Oshima. In correspondence on this new development, Krupp stated that they were not particularly eager to give to the Japanese the required information on chromadur production and machining.

The brief instruction on tinidur received by Tarutani in October was by itself incomplete so long as the Japanese had not received precise information concerning the manufacture of both alloys, the method of rolling, the heat treatment, etc. To cover that additional information, the Japanese Navy planned to negotiate an

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agreement with Krupp, and Japanese technicians planned to visit Essen during the latter part of December or early January.

Although a draft agreement had been prepared by 21 December 44, correspondence nevertheless reveals that Krupp did not view the matter with any pleasure and insisted that care must be taken that too far-reaching obligations as regards manufacture of the turbine-blades were not assumed. By late December, however, the Krupp plant at Essen had, to quote a Krupp letter, its production and manufacturing shops "disturbed", and while Krupp, Essen, could take care of theoretical instruction of the Japanese, the practical instruction would have to take place at some other German firm to whom Krupp had granted manufacturing rights.

It is evident that Krupp was stalling for time. They requested that nothing be done until the draft agreement was completed and pointed out that, because of idleness of the plant at Essen, it would be impossible, as of late December 44, to make detailed plans for practical instruction of the Japanese at another firm. The correspondence indicates that Krupp's apprehension was not based on the Japanese acquiring knowledge concerning the production of turbine-blades from tinidur, but rather that

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the release of such information to the Japanese would enable them to apply the information obtained from Krupp throughout the field of rust-proof steels. That application would gain added weight if supplemented by the release of manufacturing rights for chromadur. Krupp stated in correspondence that instruction of the Japanese Navy in methods of producing tinidur and chromadur and the manufacture of turbine-blades from those alloys was consented to "purely for patriotic reasons".

The Japanese continued to press the negotiations as a matter of the greatest urgency, whereas Krupp insisted on regularizing the negotiations by conclusion of an agreement and were not anxious to give the Japanese any instruction until the contract had been signed. The Japanese anxiety probably is explained in a statement by Krupp that the two steel alloys were absolutely indispensable for the manufacture of the Junkers turbo-jet unit. There was considerable discussion over the fee claimed by Krupp for the release of manufacturing rights and in the sequence of installments by which the money should be paid. In mid-January 45, the appropriate government agency endeavored to speed up the negotiations, pointing out that the OKL considered the instruction

desired by the Japanese as absolutely necessary in the interests of joint conduct of the war.

The agreement finally was signed in Berlin on 12 February 45. The attitude of the Japanese is perhaps best illustrated by the fact that they desired to make an immediate lump sum payment of the necessary fees, rather than payment by installment. Immediately on conclusion of the agreement, the Japanese requested when and where the necessary instructions could be given, pointing out that their representatives were available at any time and that it was considered important to have the whole matter concluded as quickly as possible. Instruction on smelting of the alloys was arranged to be given at the Krupp plant at Magdeburg and the forging of the turbine-blades at Essen, after the Japanese representatives had visited Magdeburg.

The developing ground situation in western Germany now overtook the negotiations for instruction of the Japanese. The visit of the Japanese representatives was delayed by the transfer of the Japanese Naval Commission to Thuringia. Furthermore, the Japanese representatives apparently were extremely reticent to visit Essen, probably--since the time was now mid-March 45--

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because of the developing situation along the Rhine. It was requested, therefore, that all the necessary instruction be given at Magdeburg. The most recent letter in the captured file was dated 29 March 45; as of that date it was clear that the Japanese representatives had not visited either Essen or Magdeburg but representatives do appear to have witnessed a trial smelting of tinidur at some time after that date.

From the available evidence, it appears that Japanese knowledge of chromadur is limited to percentage composition and physical data only. There is no indication that any information on the smelting and processing of chromadur ever reached Japan. Thus Japan's knowledge of the Krupp high-duty steels is restricted at best to tinidur, the alloy which apparently was only for interim duty, pending development of the more suitable chromadur. While Japan may have been in possession of details of the physical data, general machining techniques and a sample smelting process, the extent to which that information could be capitalized upon depended on Japan's possession of the necessary equipment and basic raw materials, and on the skill of her metallurgists. Tarutani, the Japanese representative who visited the Krupp plant, did not return

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to Japan. He reportedly still was in Germany at the end of the European war.

b. Ceramics: Because of a lack of temperature and corrosion resisting steels, and the lack of suitable means of cooling common steels, the Germans, during 1945, had started research on the development of ceramic blading for turbines. The work, as of VE-day, was in the early stages and no satisfactory turbine-blade had been developed. The work was greatly retarded by the successful development of the gas turbine with hollow water-cooled blades. On the basis of available knowledge on German research, the Germans had nothing to offer the Japanese on ceramic turbine-blades.

Nevertheless, the Japanese are skilful in the use of ceramics, a field in which they have long experience. In view of the limited knowledge which they acquired of the special steel alloys, tinidur and chromadur, which the Germans developed for turbine-blades, and of the reported difficulties which the Japanese have encountered in satisfactory cooling of metallic turbine-blades, it is possible that they may have turned to ceramics as a solution of the problem. There is no evidence of the passing to the Japanese of information on German experiments

in this field, but it is possible that the Japanese were aware of the experiments and that this awareness may have directed their attention along similar lines. It may be of interest, therefore, briefly to review German progress and trends in the field of ceramics for use in turbo-jet units.

German work on ceramic turbine-blades began several years ago, but received little official support until the final stages of the war, when the simultaneous importance of turbine engines and the lack of suitable alloy steels became apparent. The use of ceramics was considered largely only as a means to an end, and was considered for development only in application to low stressed parts. Research was initiated with existing commercial ceramic materials, which were developed largely for their electrical insulating properties. Those materials had poor strength properties and high expansion qualities under heat; little success was attained until more suitable materials were obtained.

The greatest difficulty was experienced in the design of a ceramic turbine-blade which would resist heat and shock without cracking or breaking. In order to permit turbine operation at temperatures above 1,000° C in

the absence of virtually all alloy steels of the chrome, nickel, molybdenum, tungsten types, a four-stage turbine, employing ceramics for all parts in contact with the gases, was designed. It was for this project that serious ceramic work was initiated. Although retarded by the advent of the water-cooled turbine rotor, ceramic turbine research was continued, but only limited progress had been made.

Moulding, extruding and pressing all had been investigated as methods for forming the blades. Blades were made either solid or hollow, and were formed either by extrusion or, in the case of non-plastic powders, by a vibration packing method. The greater the degree of compressing the material, the lower its shrinkage when fired. Interesting progress was made in forming blade shapes, but the problem of thermal expansion had not been successfully overcome.

Samples of German ceramic blades show that little attention was given to stress concentration by the absence of generous fillets. The blades were mounted on the rotor by clamping them between two concentric plates, and considerable difficulty was encountered because of the different rates of thermal expansion of the blading and the clamping plates. Captured data indicates that

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ceramic blades could be manufactured and operated at temperatures not exceeding 700° C, but apparently only static tests had been carried out at the higher temperatures at which the blades would be required to operate in a turbo-jet unit. Blades also were tested under centrifugal force at speeds up to 20,000 revolutions per minute, but without the application of heat.

Many commercial ceramics were tested for suitability in turbine-blading; the most promising ceramic was a mixture of powdered iron and aluminum oxide, which permitted operating at higher stresses because of the plasticity of the iron at high temperatures. No ceramic engineers apparently were employed on the development work, and all materials development was left to commercial firms, who had little time for such work.

No work was done on ceramic coating of metals as a protection against the effects of corrosion and high temperatures.

According to a German Air Ministry official, who was charged with the responsibility of all investigations into the theory and practice of jet- and rocket-propulsion, it was hoped by the end of 1945 to use ceramics for stator blades in turbo-jet compressors and turbines.

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The use of such blades would enable operating temperatures to be increased to 1,000° - 1,200° C, with a corresponding increase of efficiency. The results achieved up to the end of the European war were not regarded as good enough to warrant the inclusion of ceramic blades in operating turbo-jet units.

The V-1:

In August 44, the Japanese in Berlin received from the German Air Ministry part of the explanatory documents on the V-1 and apparently were to be given an explanation of the weapon shortly thereafter. It is possible that the explanatory documents on the V-1 consisted of the printed official German secret handbook on that weapon. A copy of that handbook--which is in several parts and very detailed as to operational techniques and constructional data--was on board the U-234.

In October the Japanese began negotiations to purchase manufacturing rights for the V-1 and ten samples of the remote piloting apparatus. In January 45 they obtained detailed particulars of dimensions of the leaf springs of the intake valve and of the composition of the alloy used in making the springs. In addition, information was acquired concerning the thrust of the power unit at various speeds and altitudes, certain details of the entire power unit and the location of the spark plug.

Also in January 45 the Japanese in Berlin were endeavoring to procure and transport to Japan by German submarine a number of items, including drawings of the V-1 and V-2. Japanese Army authorities in Germany about that

time secured manufacturing rights for the Argus power plant of the V-1 and plans obtained by the Army were being prepared for shipment to Japan by submarine. Captured OKL archives contain an 8 January 45 letter from the OKL to the Argus Company stating that the OKL had agreed to a Japanese request for purchase of the manufacturing rights for the Argus propulsion unit. The Japanese were requested to specify the important parts of the unit, the manufacturing rights for which they apparently previously had made request in general terms. The Argus Company had been notified immediately to prepare the necessary drawings.

In February an inspection was made of the V-1 propulsion unit at the Argus Company and considerable detail was obtained on construction, trial operation, type of fuel used and the theoretical fitting of Argus units to ordinary aircraft. At this time the Japanese showed great interest in the possibility of putting a pilot in the V-1.

Bringewald and Ruf (Messerschmitt technicians who surrendered with the U-234 while en route to Japan) stated that the V-1, in its standard form, would have been useless as a regular aircraft, since it did not have any control surfaces, nor did the overall aerodynamic form

comply with conventional piloted aircraft specifications. They were of the opinion that it would not have been difficult to make certain changes in the basic form of the V-1 in order to use it as a conventional aircraft; the necessary changes would have had to include the installation of control surfaces, strengthening of the wings, and complete rebuilding to enable speed regulation.

Such a modified V-1, however, unless completely rebuilt, would have been impossible to maneuver or pull out of a dive and could have been used only in suicide flights. The only maneuvers which the pilot could have made would have been small changes of course. To the best of their belief, it would have been quite possible to launch a V-1 from a naval type aircraft catapult, with, if necessary, take-off rockets for additional speed.

Nieschling (also captured on the U-234) had heard from Tomonaga (one of the two Japanese technicians on the U-boat) that the Germans had given the plans for the V-1 to the Japanese shortly after the weapon was first put into operational use. Nieschling believed that the Japanese already had started, or were about to start, production of the V-1. Shoji (the other Japanese technician on the U-boat) during the trip asked several members of the

German party what they thought about using suicide pilots in the V-1. Nieschling believed that the Japanese already had planned to do this and that Shoji was just fishing for reaction. It was brought up that the V-1 could be built much more quickly and cheaply than the aircraft which the Japanese currently were using for suicide attacks. In further interrogation, Nieschling stated that it was his belief that the Japanese had all the information on the V-1 and had had for some time, and that they planned to use the weapon in connection with their suicide pilots. It should be remembered, however, that Nieschling was not a technician, nor was he in a position to be well versed in German-Japanese technical liaison.

Bringewald and Ruf also stated that they were convinced that the Japanese received information on the V-1, in which missile they constantly showed great interest. One of the technicians reported that he had overheard a conversation between Otani and another Japanese who stated that plans for the V-1 were supposed to have been sent to Japan by submarine. However, the German technicians did not believe that the Japanese possessed enough information concerning the V-1 to produce it.

The same sub-assembly and main assembly plants that produced Baka should have been in a position to

manufacture comparable parts for a piloted version of the V-1. The impulse-duct jet unit should not have presented insuperable production problems.

Again a Japanese P/W, believed knowledgeable and reliable, stated that a jet-unit, based on German designs, and of which he drew a sketch, was in production in Japan as of early this year, and that it was to be used for suicide weapons. His sketch, together with his comments on the operation of the jet-unit, leave little doubt that the unit in question was the Argus propulsion-tube, or a Japanese modification thereof. In view of the possible Japanese development of an aircraft powered by one or more Argus tubes, it is of interest to note that Messerschmitt's experiments with such an aircraft--the ME-328--were known to the Japanese.

The Messerschmitt Company several years ago experimented with an aircraft powered by two Argus propulsion units slung under the wings. That aircraft--a fighter or fighter-bomber--was to have a maximum speed of 375 mph at sea level and a cruising range of 250 miles with a one-ton bomb load. At the time of the experiments, the power unit had not been perfected and as a result the aircraft did not reach the test flight stage. The Argus

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unit, in any case suffered from the fact that its fuel consumption was three times that of the turbo-jet unit, that vibration was great and the durability of the power unit doubtful. The Argus tube, however, was to be investigated as a possible power unit for aircraft.

According to information obtained in Germany, it was proved that the vibration and noise in the long run became unbearable to the pilot. The project, which envisaged an aircraft with wooden wings and a sheet steel fuselage, was abandoned, partly because of its unsuitability and partly because of the successful development of, and concentration of effort on, turbo-jet units. On the other hand, the Germans, in the closing stages of the war, produced a version of the V-1 modified to accommodate a pilot. Although the piloted V-1 was never identified in operational use, the number built--more than 500 were found in Germany--together with the discovery of a two-seater version, presumably for training, suggest that the Germans had developed the piloted V-1 to a stage where operational use was imminent. The German modification of the V-1 to accommodate a pilot did not require an unusually large amount of change.

The Campini engine-driven jet unit:

On 30 November 1941 a Caproni-Campini jet-propelled aircraft flew from Milan to Rome; the aircraft, known as the CC-2, used the Campini jet-propulsion system, in which a nozzle duct ran the entire length of the fuselage. In the forward portion of that duct an engine-driven axial compressor raised the pressure of the air entering at the nose and created a flow towards the aft portion of the duct. The resultant air stream first absorbed heat in cooling the engine and was then joined by the engine exhaust gases which further increased its thermal value. The expansion towards the exit was intensified by the addition of liquid fuel injected and ignited in the vicinity of the discharge nozzle.

Japanese representatives in Italy and in Berlin evidenced considerable interest in the Campini system of aircraft propulsion and efforts had been made prior to April 44 to buy plans for the Campini power unit. A twin-engined aircraft was being projected on the basis of results obtained with single-engined types (presumably like the CC-2). Although plans for the twin-engined aircraft had not been completed as of April 44, it was expected that the twin-engined type under design would achieve a maximum speed in excess of 500 mph.

Negotiations with the Campini firm apparently progressed favorably and rapidly, since, in May 44, a contract to purchase the Campini power unit was concluded and preliminary arrangements were made to acquire the following:

(i) Designs and production sketches for a twin-unit aircraft (using two DB-605 engines) designed for a top speed of 530 mph at an altitude of more than 26,000 ft.

(ii) Designs and sketches of the Campini propulsion mechanism as fitted to the usual twin motored aircraft.

(iii) Design and sketches of aircraft.

(iv) All Campini research material on Campini power units.

(v) Manufacturing rights for the Campini power unit for fighter aircraft utilizing aircraft engines in present use.

It appears that the Japanese had arranged with Campini for the latter to design aircraft based on Japanese ideas.

Early July 45 photographic coverage of Himeji airfield in Japan revealed the presence of four unusual

aircraft, two of which were still under assembly. Those aircraft had a wing span of 47 ft, a length of 41 ft and each had two nacelles 15 ft long. The length of the nacelles suggest the possibility that each housed a power unit based on Campini design.

As has been previously noted, captured documents indicate that the Japanese had under development a Campini type jet unit using a low powered internal combustion engine to drive the compressor. U.S. Navy reports of a preliminary survey of the Yokosuka experimental base state that approximately 20 assembled Campini type power units were found there. The power unit used a compressor driven by a light engine copied from the British Cirrus 4-cylinder, air-cooled engine taken from trainers and remodeled for the new application. This power unit, which carried a nameplate "Hatsukaze Model 11" was intended for installation in a new version of the Baka, the Baka 22, of which more than 40 sample fuselages were found.

German jet technicians destined for the Far East:

In his April 44 letter to Göring on the subject of release to the Japanese of information on the ME-163 and ME-262, Milch suggested that German assistance to the Japanese in that field should consist of providing all necessary blueprints and plans, sample aircraft, and technicians to assist in the manufacture of the aircraft in the Far East. That offer of technicians apparently met with the immediate approval of the Japanese and efforts were made to arrange for transportation to Japan, in a Japanese submarine scheduled to leave Europe shortly thereafter, of Messerschmitt design engineers.

The Japanese requested designers for both fuselage and propulsion unit of the Messerschmitt rocket plane and indicated that the technicians would be required to stay in Japan for about a year--a period based on a Japanese estimate of how long it would take to complete the first aircraft. It appears that the Navy's interest was in technicians for the ME-163, while the Army's interest was with respect to the ME-262. While the Navy required technicians for one year only, the Army stipulated a two-year period.

On 15 June Army representatives in Berlin indicated that they would like to have Chlingensperg--a Messerschmitt

technician--visit Japan for a period of two years. His principal work would be that of designing short-range fighters and long-range bombers at the Kawasaki plant and, in addition, directing conversion to the manufacture of the ME-262. The negotiations indicate that the principal aim of the Army and Navy was not merely that of getting materials for study, but also that of getting technical help, in order that plans for the speedy development of jet and rocket aircraft could be realized. Appropriate technicians were given first priority for transfer to Japan.

Apparently, however, negotiations for the services of technicians did not proceed too smoothly. The plan was to send to Japan three rocket technicians, one of whom would be concerned with launching, one with plans and the third with construction. Trouble, however, was being experienced in obtaining German agreement to the proposals. It was proposed, therefore, if German technicians were not available, to train three Japanese technicians in Germany and have them return to Japan as soon as possible. The Japanese technicians specified were Suematsu, Tarutani, and Kawakita.

In September, Army representatives in Berlin, as a result of conferences with the Messerschmitt Company, were ready to come to an agreement for the services of three Messerschmitt technicians--Chlingensperg, Schomerus and Bringewald. The first two of these were to direct designing of short-range fighters and long-range bombers, while Bringewald would have the chief task of directing manufacture of the ME-262. In addition, the technicians were to carry with them from Germany preparatory materials and data and were to be employed in Japan for a period of two years. Among those materials and data were to be important design data on short-range fighters and long-range bombers, such as the ME-209, ME-309 and ME-264--the direction of designing of which presumably was to be the responsibility of Chlingensperg and Schomerus--and reference material on twin-engined fighters (such as the ME-410) and new large type gliders (such as the ME-323). Bringewald was to give the necessary cooperation in designing and construction of rocket aircraft, such as the ME-163 and ME-262. The financial arrangements had been agreed upon with Messerschmitt.

The Japanese Army contract with the Messerschmitt firm was not signed until 8 November 44. Under the terms

of the contract, Messerschmitt was to dispatch a number of technicians to Japan. The contract provided for the services of Chlingensperg, Schomerus, Bringewald, Caspar (for whom Ruf later was substituted) and other, at the time undesignated, auxiliary help. The first two specialists were to have the task in Japan of supervision of development and instruction of fighters and long-range bombers; Bringewald and Caspar (Ruf) supervision of mass production in Japan of the ME-163 and ME-262.

For their duties in the Far East the technicians were to carry with them appropriate documents. Among the documents specified in the contract were those covering the ME-209, ME-309, ME-264, ME-163, ME-262, ME-410 and ME-323. The documents were to be returned with the technicians; Chlingensperg and Schomerus were scheduled for a stay of two years in Japan, Bringewald and Caspar (Ruf) for one year. Their duties in the Far East were to be carried out under supervision of the Japanese War Ministry.

Bringewald was particularly qualified to assist the Japanese in that he had been associated with mass production of aircraft at the Henschel Company, with design of the HS-130 high altitude aircraft and, from 1938, as assistant to Willi Messerschmitt had been associated with

design and mass production of the ME-110, ME-410, ME-109 and ME-323. He had made preparations for mass production of the ME-262 and was responsible for supervision of its mass production in the entire German aircraft industry.

Plans for the transportation to the Far East of both German and German-trained Japanese jet technicians proceeded apace in late 1944, but the lack of transportation negatived the preparations.

Chlingensperg and Schomerus were on the U-864 which left Norway in early February 45 and was sunk the same month. Tomonaga, Shoji, Bringewald and Ruf were on the U-234 which left Kiel in March and surrendered on the high seas on 13 May. One other U-boat was destined to leave Kiel in late January, or early February, but was bombed out in the Baltic and paid off. It thus appears that plans for the transfer of technicians to the Far East were completely disorganized. There is no evidence to assume that any qualified jet technician, either German or Japanese, ever arrived in the Far East.

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SECTION II

CONVENTIONAL AIRCRAFT

Note: Performance and descriptive data for the aircraft, engines and armament covered in Section II will be found as follows:

Conventional aircraft	TAB E
Internal combustion aircraft engines	TAB F
Aircraft armament	TAB G

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CONVENTIONAL AIRCRAFT

During the period prior to the signing of the Economic Agreement between the German and Japanese Governments, Japanese representatives in Berlin purchased sample aircraft of a number of German conventional types. When, however, after April 43, it was no longer possible to run surface vessels through the blockade, deliveries of sample aircraft to Japan ceased. In only a few instances did the Japanese representatives in Germany enter into negotiations for the purchase of manufacturing rights for conventional German aircraft. Outside of jet- and rocket-propelled types, Japan's interest appeared primarily to be directed towards individual items of equipment, the manufacture of which in the Far East would improve the combat efficiency of Japanese designed and built aircraft.

<u>DO-217</u>:

In March 1942 the Military Attaché in Berlin initiated negotiations for the immediate purchase from the GAF of two or three DO-217's. This aircraft, originally designed as a twin-engined bomber, later was modified by

the GAF for reconnaissance and night-fighter duties. It never was, however, a particular success in any field. Captured German Air Ministry records list equipment intended for shipment to Japan but which was left behind in the Bordeaux area and returned to German units. Included in that list are two DO-217 K's. The contract for purchase of the two aircraft was signed in December 1942 and the aircraft were handed over to the Japanese in Germany during the following month; such were the delays involved that, because of a lack of shipping space, delivery to Japan never was accomplished. The Air Ministry records also state that construction details of the DO-217 were handed over to Japanese representatives in Germany by the Dornier firm on 11 September 42. According to Dornier officials, the sale of the two DO-217's included a blanket license to manufacture.

<u>AR-196</u>:

There is no evidence that prototype aircraft of this standard German sea-reconnaissance fighter ever reached Japan, although two sample aircraft were handed over to the Japanese in Germany in December 43. One or more of these aircraft was carried on each of the German

surface raiders which operated in the Indian Ocean; it is possible that some of those aircraft passed into Japanese hands.

DFS-230:

Clearance for Japanese purchase of three DFS-230 gliders was given during the latter half of 1942; two of those gliders were listed as being left behind at Bordeaux. There is no evidence of the third glider, nor of any data concerning this glider type, having been sent to the Far East. A descriptive booklet on the DFS-230 was found among papers left behind in the Japanese Embassy in Berlin.

DO-335:

This unconventional German aircraft had not reached the operational stage at the close of the war. It was, nevertheless, an aircraft with very high performance capabilities and was the subject of investigation by the Japanese in Berlin. There is no evidence of Japanese negotiations for manufacturing rights for this aircraft. In view of the complicated structure of this aircraft, using as it does both pusher and tractor airscrews and engines, it is fairly certain that such information as obtained by the Japanese was totally inadequate for any attempt to copy the aircraft in Japan.

Even before the DO-335 was operational, the GAF conceived the idea of an aircraft comprising two DO-335

fuselages--each with two engines and airscrews--joined by a common wing center section. This composite aircraft was known as the DO-635. Release of manufacturing rights for the DO-635 was given on 8 January 45, if the Japanese desired those rights. An unconfirmed prisoner of war report states that data and general drawings for the DO-635 were sent to Kiel at the beginning of 1945 for shipment to Japan by submarine. In any event those data and general drawings almost certainly did not reach the Far East.

<u>FI-156</u>:

Plans for the FI-156 army cooperation and liaison aircraft apparently were purchased by the Japanese in early 1941 and drawings obtained. In addition, one sample aircraft was transported to the Far East early in the following year. In June 1942 it appears that the Japanese decided not to procede with production of the aircraft as they were already making an aircraft similar to it.

It is reported that Allied Forces found on Clark Field in the Philippines a high wing monoplane described as almost a small replica of the FI-156.

<u>FW(TA)-152</u>:

During late 1944 and early 1945 Japanese representatives in Germany exhibited a keen interest in this

aircraft, an improved version of the FW-190. In November 1944, the Japanese in Berlin were preparing to forward material on the TA-152 to Tokyo. By January 45, the Japanese Army representatives in Berlin had acquired an outline of the construction, general plans, a list of materials used in construction, and a list of equipment to be used with the TA-152.

The contract for purchase of manufacturing rights for this aircraft was not signed until 23 March 45, although release was granted in January. A captured German Air Ministry letter, dated 3 January 45, authorizes the fulfillment of a Japanese request for rights to copy the TA-152 C and H. The necessary drawings were to be prepared without delay--at least general drawings if time did not permit the preparation of full blueprints. Those drawings were to be handed over independently of the signing of the appropriate contract. The plans and blueprints were forwarded to Kiel for shipment, but did not arrive there before 15 March. Transportation to Japan, therefore, is very unlikely.

<u>FW(TA)-154</u>:

This all-wood twin-engined aircraft is believed to have been based on the British Mosquito. It was intended

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as a twin-engined night-fighter but development in Germany reportedly ran into overwhelming trouble because of a failure to produce adhesives suitable for the laminated wood structure. There is no evidence that this aircraft ever became operational in Germany. However, in keeping with Japan's interest in aircraft using wooden construction, general details of the aircraft were studied. In November 44, Japanese Army representatives in Berlin examined details of the aircraft's performance, capabilities, radar equipment and any other special features relative to night-fighting. There is no evidence of negotiations for acquisition of manufacturing rights.

<u>FW-190</u>:

During the period 1942-44 Japanese representatives in Germany collected and forwarded to Tokyo very detailed data on the capabilities and potentialities of this standard German single-engined fighter. In early July 42, Japanese representatives in Germany visited the Focke-Wulf plant at Bremen to study the FW-190. Focke-Wulf files captured on the U-234 listed two shipments to Japan in June 1941 of parts for the FW-190. In addition, two

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sample aircraft were purchased in late 1942 or early 1943. Captured German Air Ministry files indicate that those two FW-190's were left behind at Bordeaux and returned to the GAF. There is some evidence that a further two FW-190's were purchased by Japan. Although there is no evidence of delivery to the Far East of these additional two aircraft, it appears that at least one may have arrived in Japan. Captured documents indicate that one set of fourteen manuals for the FW-190 accompanied each sample aircraft; at least one set of those manuals may, therefore, have arrived in Japan.

<u>FW-200</u>:

In July 1941, Japanese representatives in Berlin apparently were considering the joint design of a super-bomber based on the FW-200. At the time of the suggestion, however, no approach had been made to Focke-Wulf, and in any case some opposition to the idea appears to have been expected from the GAF, who might object to the sale to Japan of manufacturing rights for the FW-200. However, by March 1942 discussions were proceeding on the subject of purchase of manufacturing rights for both the transport and long-range reconnaissance versions of this aircraft.

In addition, the Japanese purchase of several specimen aircraft was proposed, including an improved version of this aircraft. In July 42, Japanese representatives visited Focke-Wulf, Kottbus, to study the FW-200.

Captured Air Ministry files indicate that the Japanese purchased five sample aircraft but that delivery to Japan was never effected. In March 1943, the GAF took the position that delivery of the five aircraft was no longer justifiable in view of the U-boat war situation. The question of delivery of the aircraft was to be submitted shortly thereafter to Göring; there is no indication that the sample aircraft ever were handed over to Japanese representatives in Germany.

<u>GO-242 and GO-244</u>:

Captured German Air Ministry files indicate that specifications for the GO-242 glider were turned over to the Japanese on 3 November 42. The Japanese decided shortly thereafter to purchase two specimen gliders. At least one glider and the appropriate specifications were handed over to Japanese representatives in Germany on 3 November 42. Transportation difficulties, however, became so great that the purchase of manufacturing rights was considered instead of sample gliders.

A similar pattern was followed in the purchase of manufacturing rights for the GO-244, a version of the GO-242 powered by two radial engines. The last available information

concerning the glider and its powered version indicate that negotiations for purchase of manufacturing rights still were in progress in February 44.

HE-177:

The Japanese showed considerable interest in various German long-range bombers including both those which had reached the operational stage and those which were restricted to experimental versions only. Despite the limited operational successes of the HE-177, the Japanese, according to General Kessler, had a special interest in this aircraft and intended to purchase three sample aircraft; two aircraft were on order in January 45. The three HE-177's were to be flown to Japan via Russia. There is, however, no evidence that any of the three aircraft ever left Germany, nor that Japan ever contemplated the purchase of manufacturing rights for this aircraft.

Unexpected delays in the production of the HE-177 were encountered in Germany because of difficulties with the double engines used to power the aircraft. In an attempt to overcome the power unit problem, Germany developed a four-engined variation of the HE-177, designated the HE-277. A prisoner of war of limited reliability stated that two HE-277's were given to Japan. There is no evidence that either or both of these aircraft ever left Germany.

<u>HE-219</u>:

In July 44, following an inspection of the HE-219, Japanese Navy officials in Germany procured a detailed description together with performance data, but there has been no evidence of a request to the Germans for plans or manufacturing rights. It is possible that the Japanese may have been informed of German experiments with the fitting of an auxiliary turbo-jet unit under the fuselage of the HE-219. This form of auxiliary boost, according to captured documents, has been under study in Japan since early 1944.

<u>HS-129</u>:

Despite Germany's very limited success with the twin-engined HS-129 ground-attack aircraft, Japan purchased two sample aircraft in early 1943. According to captured German Air Ministry files release of the two sample aircraft was held up. The evidence indicates that delivery was not made until March 44, too late to allow of transportation of the sample aircraft to the Far East.

<u>HS-130</u>:

As early as 1941 the Japanese had inspected this twin-engined high-altitude aircraft fitted with pressurized

cabin. In 1943 they requested delivery during that year of one sample aircraft. As there was little chance of being able to purchase a sample HS-130, the proposal was made that drawings for the pressurized cabin should be sent to Japan by special naval means, presumably by U-boat. Those drawings are thought to have been loaded on a submarine sailing for the Far East. Apparently, however, the plans were incomplete since components and plans for the pressurized cabin again were proposed for shipment to Japan in the spring and summer of 1944. In July 44, manufacturing rights for the Henschel pressurized cabin were purchased by the Japanese Navy. Plans and parts for the pressurized cabin of the HS-130 were being transported to Japan on the U-234.

JU-87:

There is no evidence of any Japanese interest during the war in the JU-87 dive bomber. However, members of the Junkers Company stated that two sample JU-87's were shipped to Japan during 1937-38; this is substantiated by documents found in the Japanese Embassy in Berlin. No Japanese aircraft showing evidence of JU-87 design ever has been encountered.

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JU-88:

According to members of the Junkers firm and captured documents, one JU-88 A-5 and corresponding blueprints and drawings were supplied by Junkers to the Japanese Navy in 1940-1941. The Junkers personnel also stated that three JU-88 A-4's and corresponding drawings were purchased by the Japanese in 1942. Three JU-88's with spare parts were left behind at Bordeaux and handed back to the GAF in 1944; it is believed that these were the three JU-88's purchased by the Japanese in 1942. Construction and operation instructions, details of armament installations and maintenance manuals were handed over to the Japanese during the latter half of 1942, as were instructional films on servicing, flight operations and one-engined flight. Some or all of this material may have reached the Far East. There is no evidence that a contract for manufacturing rights ever was concluded.

JU-188:

In late 1943, Junkers and Japanese Army representatives entered into discussions aiming at technical cooperation on a broad basis for the benefit of the Japanese Air Forces. During those discussions Junkers

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proposed that Japan's aircraft production should be improved both quantitatively and qualitatively by adoption of recent Junkers aircraft and engines, as well as the latest Junkers production methods. To that end a start should be made with an aircraft type being manufactured in Germany on a large scale and the JU-188 was suggested as a suitable type. In its favor it was stated that it would save the Japanese the necessity of developing a new type aircraft of their own design and would, in addition, pave the way for production in Japan of the JU-388 and JU-488. There is no indication, however, that this proposal was accepted by the Japanese nor is there any evidence of Japanese interest in the JU-188.

JU-388:

In July 42, military representatives in Berlin appear to have had preliminary discussions with the German Air Force for the purpose of obtaining working plans and special parts for the JU-388. Two years later, the Japanese requested that manufacturing plans and samples of special parts for the JU-388 be supplied to allow of study of this aircraft which the Germans intended to use as a bomber, reconnaissance or night-fighter aircraft.

Considerable information on the JU-388 was supplied to Japanese representatives by the Germans and, in response to a Japanese request, manufacturing rights were released on 8 January 45. According to members of the Junkers firm, drawings for the L-1 and K-3 subtypes were handed over to the Japanese in Germany either during that month or February 45. In any event, the drawings were supplied at a date too late to allow of transportation to the Far East..

JU-488:

Apparently it was not until late 1944 that the Japanese representatives in Germany learned of the four-engined JU-488, an aircraft which had not progressed beyond the experimental stages at the close of the European war. The Japanese requested manufacturing rights, clearance for which was granted on 8 January 45. According to members of the Junkers firm, general drawings and some data for the JU-488 were handed over to the Japanese in Germany in January 45, too late for transportation to the Far East.

JU-290:

Had German plans materialized, at least one JU-290 would have been flown to the Far East, there presumably to

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be handed over to the Japanese. It was intended to establish liaison by air between Europe and Japan by using the JU-290. Differences of opinion between the Germans and Japanese as to whether a northern or a southern route should be used resulted in failure to establish an air link.

By late 43, the Japanese in Berlin had obtained general details of performance, dimensions and armament of the JU-290. There is, however, no evidence of any particular interest by the Japanese to acquire this aircraft.

<u>JU-390</u>:

In October 43, the military staff in Berlin procured descriptive data on the six-engined JU-390 and in the following July requested that manufacturing plans and samples of special parts be made available to Japan for study of performance and construction. Clearance of release of manufacturing rights was granted on 8 January 45. According to Junkers employees, drawings of the JU-390 were prepared in February 45 for supply to the Japanese, but never left the Junkers firm.

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ME-109:

It is possible that manufacturing rights for the ME-109 single-engined fighter were acquired by Japan in late 1942. In the following year the Japanese Army purchased several models of the E and G types (with DB 601A and DB 605 engines respectively); at least one ME-109 F-4 with spare parts was among the aircraft left behind at Bordeaux in 1944 and returned to the GAF. Two prototype aircraft were delivered to the Japanese in Germany in January 43. According to Bringewald and Ruf, Messerschmitt technicians captured on the U-234, one ME-109 successfully was transported to Japan in 1942 or 1943. It is probable that this aircraft, believed to be a G-4 subtype, went to Japan with Stöhr, a former Messerschmitt pilot who joined the staff of the German Air Attaché in Tokyo in 1943. In October 44 Japanese representatives investigated the Henschel aircraft production methods as applied to wings for the ME-109.

ME-209 and ME-309:

These two single-engined fighters were proposed at varying times by the Germans as replacements for the ME-109. Neither, however, ever reached the operational

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stage. In late 1943, Germany apparently had no objection to manufacture in Japan of the ME-309 to meet Japan's then pressing need for a fighter aircraft. Although study of the ME-309 temporarily had been halted, Messerschmitt was continuing to manufacture trial aircraft and had reached the stage of test flying.

Captured documents show that both the Japanese Army and Japanese Navy made continual inquiries concerning the aircraft themselves, Messerschmitt variable pitch propellors and reproduction rights. In December 43, the Japanese military representatives in Berlin had obtained permission to purchase a sample ME-309 and manufacturing plans. Late in the following February, they were in negotiation with the Messerschmitt firm and the German Air Ministry, and the contract for purchase of manufacturing rights having been completed, drawings are thought to have been available for shipment to Japan as early as May 44. There is no evidence as to whether or not those drawings actually were shipped to the Far East.

The first examination of the ME-209 by the Japanese in Berlin was in February 44. There is evidence that manufacturing rights for the ME-209 were purchased by the Japanese Army some time after July 44, and drawings

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and special parts are believed to have been obtained. Plans for the ME-209 and ME-309 are believed to have been carried on the U-864; von Chlingensperg, a Messerschmitt technician who was a passenger on that submarine, was to supervise manufacture of the two fighters in Japan.

ME-210:

Clearance for delivery to the Japanese in Germany of five sample ME-210's and appropriate aircraft assembly drawings was granted during the latter half of 1942. Three prototype aircraft were delivered to Japanese representatives in Germany in January 43. At least two sample ME-210's purchased by the Japanese representatives in Germany were among the equipment left behind at Bordeaux and returned to the GAF. However, one sample ME-210 is believed to have been shipped to Japan by surface blockade runner in 1943; captured files indicate that a second sample aircraft was delivered during that year. In July 44, the Japanese endeavored to procure and send to Japan drawings and special parts for the ME-210, together with a technician qualified to supervise its construction in the Far East. This suggests that the

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Japanese had plans for development of the ME-210, the extent of realization of these plans is not clear. It is possible, however, that the Japanese may have planned to introduce a twin-engined aircraft based on this German type.

According to Messerschmitt officials, the first negotiations between that firm and the Japanese took place in 1942, in response to a desire by the Japanese to utilize Messerschmitt design techniques and experience to improve the quality of Japanese combat aircraft. Original plans visualized the employment at Messerschmitt, Augsburg, of a number of Japanese technicians; operating under the personal supervision of Professor Messerschmitt, they were to develop a very long-range twin-engined fighter, based on, and an improvement of, the ME-210. Negotiations to that end were fruitless.

<u>ME-410</u>:

In February 44, the Japanese Army obtained information concerning the ME-410, including performance data, together with armament details and information as to how this aircraft differed from the ME-210. Possibly because of the similarity between the ME-210 and ME-410

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fuselage, manufacturing drawings were not requested by the Japanese. However, plans for the ME-410 reportedly were carried on the U-864 by von Ohlingensperg and Schomerus.

In mid-October 44 the Japanese in Germany investigated Henschel mass-production methods as applied to center wing spars for the ME-410.

ME-264:

The Japanese showed great interest in this four-engined bomber which the Germans never developed to the operational stage. Army investigation in 1943-1944 covered detailed outlines of its capabilities together with information on construction and performance. The aircraft was at one time suggested for use in flights between Europe and Asia, and there was a suggestion that, if required by Germany, all possible Imperial Army personnel and aid would be given to its development. Subsequently Japanese interest wained, probably since the Messerschmitt firm was compelled to slow down its development of the ME-264 because of requirements in satisfying the GAF's needs for other Messerschmitt aircraft types. There is no evidence that drawings or parts ever were shipped to the Far East.

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ME-323:

In 1942, Germany offered to Japan five samples of the six-engined ME-323 transport aircraft, but as shipment to Japan was impossible, the Japanese desired to purchase manufacturing rights instead. Subsequently the decision to buy rights was rescinded but operational data was obtained and study of performance and construction arranged. There is no evidence that manufacturing rights for the aircraft ever were purchased by Japan; however, drawings and descriptions of the construction of the ME-323 were on board the U-234.

Mistel:

In mid-1944, the Japanese in Germany obtained several detailed descriptions of the structure and operations of the Mistel aircraft--an explosive JU-88 carried under, and released from, an ME-109. It is thought that drawings of the most important parts of the aircraft and of the explosive equipment were loaded for shipment to Japan during the second half of 1944. Plans also were in hand to have one representative each from the Japanese Army and Navy trained in its use in Germany.

Internal Combustion Aircraft Engines

Introduction:

Available evidence indicates that prior to 1944, the Japanese were allowed to purchase sample equipment and plans only for German aircraft engines which had reached the production stage.

Japanese negotiations with reference to experimental engines, such as the Jumo-222, Jumo-223 apparently did not develop until mid or late 1944. Samples of the older aircraft engines were purchased in time to allow of shipment to the Far East by surface vessels; it is probable, therefore, that at least some of those engines arrived in the Far East. In the later stages, however, when only U-boats were available for blockade running, the Japanese had to restrict their interests to negotiations for purchase of manufacturing rights and the necessary blueprints and plans.

AS-411:

Information on this Argus medium horsepower liquid-cooled engine apparently was obtained at an early date, and the Japanese are believed to have been manufacturing an engine similar to the Argus prior to June 42.

However, according to German Air Ministry records, clearance for delivery to the Japanese of two AS-411's was granted in late 1942. Delivery of those two engines to Japanese representatives in Germany was made in July 43.

<u>BMW-801</u>:

In May 1942, Japanese Navy representatives in Berlin opened negotiations to purchase three prototype BMW-801 14-cylinder two-row radial engines; manufacturing rights were not requested. In mid-August 42, Japanese representatives visited the BMW plant at Munich to accept delivery of the three engines; the following month engine handbooks were handed over to the Japanese. During the latter half of 1942, approval was given to the German Air Ministry for sale to the Japanese of four sample BMW-801's. Three of the engines had been shipped to the Far East by July 43; only one is known to have been sunk en route. There is later evidence that the Japanese possibly were making use of the BMW-801.

<u>BMW-803</u>:

In November 42, Japanese representatives in Germany visited the BMW plant at Munich to study this

18-cylinder two-row radial engine, though it appears that manufacturing rights for the BMW-803 were not acquirable. In late 1943 the Japanese Army was anxious to purchase three BMW-803's; that engine, however, progressed in Germany only to the experimental stage.

DB-601:

In late November 36, a license for manufacture of the DB-600 was sold to the Aichi firm; according to Daimler-Benz officials, Aichi used the license only for development and study purposes, not for series production. On 7 June 39, Aichi and Kawasaki were given a license for manufacture of the DB-601 A/B; representatives of those Japanese firms visited Daimler-Benz to study production methods for the DB-601. One sample DB-601 12-cylinder liquid-cooled engine is believed to have reached Japan prior to July 43. The engine was under construction in Japan; the Kawasaki liquid-cooled engine used in the Tony single-engined fighter reportedly is a copy of the DB-601.

DB-603:

During visits to Daimler-Benz to study DB-601 production, Japanese representatives first became aware of the DB-603, in which they showed great interest. In

May 41, the Japanese Army applied to purchase, for use as study material, five DB-603 12-cylinder liquid-cooled engines and were prepared, should the necessity arise, to purchase manufacturing rights. The desire for purchase of the five prototype engines was repeated in June 42; at this point, however, manufacturing rights were not wanted. German Air Ministry clearance for delivery to the Japanese of four DB-603's was granted during the latter half of 1942. Four engines were delivered to the Japanese in Germany in January 43, two for the Japanese Army, two for the Japanese Navy; two of those four engines may have reached Japan by the following July. In June 44, four more engines were handed over by the Germans, and in July Japan requested manufacturing rights.

A license covering manufacture of the DB-603 E in Japan was granted to the Japanese in March 45; Daimler-Benz officials stated that in November 44 Japanese representatives in Germany were given plans for that engine, the plans being packed in sealed containers ready for shipment. Transfer of those plans to the Far East, however, is considered unlikely. Japanese representatives in Germany were scheduled to visit a Daimler-Benz factory to study DB-603 E production in November 44; according to

Daimler-Benz officials, that visit was postponed several times and never took place.

Apparently, however, Japan's interest in this subtype was directed mainly toward the two-stage mechanical supercharger with which it was fitted; negotiations were to be initiated with respect to this supercharger. In November 44, the Japanese Army was said to be planning to put into production in Japan the DB-603 as it stood. The good features of the engine--presumably the supercharger and, possibly, the water-injection boost system--were to be incorporated in engines already being trial manufactured by Kawasaki. Those engines, referred to as the HA-140 and HA-240, presumably were developments of the HA-40, the Tony engine, which reportedly is a copy of the DB-601.

<u>DB-605</u>:

Information on this 12-cylinder liquid-cooled engine was obtained in early 1942. It is possible that prototype engines arrived in Japan prior to July 43. Clearance for delivery to Japan of five DB-605's was granted in late 1942; in July of that year Japanese representatives began a one-month visit to the Daimler-Benz plant to study the DB-605.

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DB-606:

The DB-606 was the first "twin" engine produced by Daimler-Benz; it consisted of two DB-601's mounted side by side and geared to a common crankshaft. According to Daimler-Benz officials, Japanese representatives in Germany in early 1942 were given manufacturing drawings of the DB-606 twin-motor gear drive; no other manufacturing plans for, nor any technical advice on, the engine subsequently were given to the Japanese.

Jumo-205:

According to employees of the Junkers firm, two samples of the Jumo-205 six-cylinder diesel-type liquid-cooled engine were delivered to Japanese representatives in Germany. Although there is no available record of their arrival in Japan, they were handed over at an early date, when transportation was available.

Jumo-207:

In July 42, Japanese representatives visited the Junkers plant at Magdeburg to study the B-subtype of this supercharged six-cylinder diesel-type engine; during 1942, two sample engines were delivered to the Japanese, but are believed to have been sunk en route to the Far

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East. In 1944 the German Air Force revealed details of the improved C and D subtypes, each of which is fitted with a turbo-supercharger. In January 45, the Japanese Army ordered two Jumo-207 engines and fuel injection pumps; manufacturing plans were to be obtainable in July 45.

<u>Jumo-211</u>:

The Japanese Army was interested in March 42 in the acquisition of manufacturing rights for this twelve-cylinder liquid-cooled engine. Four prototype engines--of the J-subtype--ten fuel injection pumps, one instructional film and engine handbooks (for the F and J-subtypes) were handed over to the Japanese in Germany during the latter half of 1942. Information regarding transfer to Japan is available only in respect of two of the engines, one of which was sunk en route; the other may have arrived there.

<u>Jumo-213</u>:

In March 43, the Germans offered the Japanese Army manufacturing rights for the Jumo-213. Two samples of this 12-cylinder liquid-cooled engine were supplied by Junkers to Japanese representatives in Germany in December 43,

and a further three in the following February. There is no record of shipment of the engines to Japan. Evidence suggests, however, that production of the engine in Japan was under consideration; the Japanese appeared anxious to have sent to Japan an engineer skilled in its production.

Jumo-222:

In early April 43, the Japanese military representatives in Berlin obtained considerable data on the 24-cylinder liquid-cooled Jumo-222. It was not, however, until almost eighteen months later--in November 44--that negotiations were begun for purchase of manufacturing rights for the Jumo-222, as study material in high-powered engines.

In late November 44, the German Air Ministry authorized the sale by the Junkers firm of manufacturing rights for the A/B-3 sybtypes of the Jumo-222; in early January 45, approval also was given for the release to Japan of sample important parts of the engine and of manufacturing rights for the E/F subtypes. According to Junkers officials, negotiations with the Japanese Army, covering manufacturing rights and all necessary papers and plans for the A/B-3 and E/F-subtypes began in

December 44. The Japanese, during the negotiations, insisted on quick delivery of the plans; two sets of those plans were sent from Junkers to Kiel for transportation to Japan, the first set being delivered on 12 January 45, the second set the following March. In view of date of delivery, it appears unlikely that either set of plans arrived in the Far East. The Japanese also were anxious to have sent to Japan German technicians familiar with the Jumo-222.

Jumo-223:

In March 44, Japanese Army officers in Berlin acquired technical data on the Jumo-223, a 24-cylinder engine, made up of four Jumo-207 diesels arranged in box-form and fitted with a turbo-supercharger. Only two experimental engines had been built and production in Germany apparently was not to be started. The Japanese Navy, nevertheless, was negotiating for purchase of one of two experimental engines. In late October, however, the Navy began negotiations for manufacturing rights, in order to obtain plans for the engine, rather than purchase a prototype engine. A German Air Ministry letter of 7 December 44 informed the Junkers firm that the Japanese Naval Attaché had requested delivery of two complete sets of drawings for the Jumo-223. The letter also stated that a Japanese

party had visited Junkers early the previous October, and had there inspected the plans.

On 17 January 45, the German Air Ministry informed the Japanese Naval Attaché that the Junkers firm had been authorized to sell manufacturing rights for the engine and had been instructed immediately to prepare two sets of drawings capable of being blueprinted. According to Junkers employees, those drawings were handed over to the Japanese Naval representatives. The drawings were received, however, at a date which made transportation to Japan unlikely. One set of the drawings was captured in Germany in the possession of the GAF officer designated to be adjutant to General Kessler in Tokyo.

<u>Superchargers</u>:

In November 43, Japanese Army representatives learned that the DB-603 engine apparently was being remodelled, and that the resultant modified engine would be known as the DB-627. One month later they requested drawings for the two-stage supercharger fitted to the DB-627; in August 44 a request was made for a sample supercharger. There is no indication of shipping to the Far East of either drawings or sample equipment.

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Engine power boosts:

In connection with negotiations for the newer types of German aircraft engines, the Japanese became aware of, and greatly interested in, German methods of increasing the power output of aircraft engines by injection of boosting materials. Two boost methods in particular were considered--nitrous oxide (GM-1) and liquid oxygen injection--and, in December 44, an investigation of German boost systems had been carried out by Army and Navy representatives.

The Japanese learned from those investigations that because of the problem of suitable containers, injection of liquid oxygen was difficult; as a result nitrous oxide--obtainable in large quantities from the atmosphere--was being used in Germany and had solved the oxygen-injection problems. The Japanese, therefore, concentrated on the study of nitrous oxide injection.

On 3 January 45, the German Air Ministry authorized release to the Japanese of rights for production of the GM-1 installation, complete with tank and valve. As the matter was one of urgency, a set of drawings capable of being blue-printed was immediately to be prepared for acceptance by Japanese representatives; if suitable drawings could not

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be prepared within a short time, at least general-view drawings were to be completed as quickly as possible. According to a German P/W, technical manuals and pamphlets on the GM-1 installation were handed over to the Japanese in Germany in December 44; on the other hand, another P/W places the date of handing over of GM-1 information as being in April 45. Whether the date be December 44 or April 45, it is extremely unlikely that any tangible information on GM-1 arrived in the Far East.

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Aircraft Armament

MG-15 and MG-17 (7.92 mm):

The Japanese Type 98, 7.92 mm machine gun is a facsimile of the German MG-15 flexible gun. The gun, which has been found in a number of Japanese light and medium bomber aircraft, was made experimentally at Yokosuka, and produced at the Nagoya Arsenal and one other unidentified arsenal. It is believed that manufacturing rights for the MG-15 were acquired prior to the war; according to German Air Ministry records, licenses for both the MG-15 and MG-17 were granted at some date prior to June 43. Manuals for the MG-17--fixed 7.92 mm gun for use in fighter aircraft--were handed over to Japanese representatives in Germany on 1 August 42, and for the MG-15 early in the following month. Rheinmetall-Borsig files show that fifty-seven MG-15's and one hundred and ninety-nine MG-17's, together with descriptive data, were delivered to Japanese representatives in Germany before 31 December 1942.

MG-81 (7.92 mm):

This improved flexible machine gun was the subject of investigation by the Japanese in March 42. The MG-81 was superior to the MG-15, and shortly was to

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replace that gun in operational German aircraft. Purchase of manufacturing rights was necessary as, without such purchase, the Japanese would not be able to negotiate for delivery of a small number of sample guns. On 9 September 42, the MG-81 weapons manual was handed over to the Japanese in Germany; this was followed in November by other relevant documentary material. By June 43, sample MG-81's had been released to the Japanese. It is not known which of this material arrived in the Far East; it is probable that at least the documentary material was shipped.

Manuals on, and samples of, the "Bola-81Z" also were handed over in late 1942 or early 1943; that installation is the twin MG-81 gun mount fitted in the ventral position on German twin-engined bombers. Some or all of this equipment probably was shipped to the Far East.

MG-131 (13 mm):

In late October 41, the Japanese Army first obtained information in Germany on this 13 mm machine gun, designed for use as a fixed gun on fighters and as a flexible gun--either hand-operated or in a power turret--on bombers. At that time it was not possible to obtain

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sample equipment; the Germans, however, were anxious to sell the manufacturing rights to the Japanese.

In early August 42, Japanese representatives visited Rheinmetall-Borsig--the manufacturer--to study the MG-131; that visit was followed by one in October to the Heinkel plant to study gun-mounts for the MG-131. The MG-131 weapons manual was turned over to the Japanese in Germany on 13 August 42. Five MG-131 machine guns--with ammunition--and three mountings were listed in Rheinmetall-Borsig deliveries to Japanese representatives in Germany which took place by 31 December 1942.

Apparently the Japanese Army and Navy pursued independent negotiations for the MG-131. According to German Air Ministry records, a license--presumably for manufacture--for the hand-operated MG-131, together with sample guns had been released to the Japanese by June 43. The evidence suggests that the Japanese Army was the recipient; in early June 44, Naval representatives in Berlin also had received plans, and appear to have obtained a large quantity of MG-131's and ammunition which had been purchased and stored in Germany, but delivery of which was proving difficult because of the increasing needs of the GAF. In August, the Japanese Navy was planning to

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ship plans for the flexible MG-131 to Japan but it is doubtful whether those plans ever reached the Far East.

In the meantime, the Army apparently had decided not to acquire manufacturing rights for the MG-131. The Navy, however, completed an agreement with Rheinmetall-Borsig on 24 August 44 for manufacturing rights for the MG-131 and ammunition. The Japanese Navy Type 2 13-mm gun reportedly is derived from the German MG-131.

The MG-131 also was used as a remote-controlled gun on the ME-210. That armament installation was of great interest to the Japanese Army. By late March 42, Army representatives in Berlin apparently were hoping for the successful completion of negotiations for sample guns and ammunition, and, probably, also manufacturing rights. In July 42, arrangements had been completed for purchase of three sample remote-controlled guns as used in the ME-210, together with sample tracer, armor-piercing and explosive-incendiary ammunition. It is probable that at least one set of sample equipment arrived safely in the Far East; installation drawings also presumably reached Japan.

In connection with the MG-131, the Japanese Navy, in September 44, concluded an agreement covering

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manufacturing rights for the steel cartridge belt and feed-block for the MG-131. Also in September 44, a contract was signed for the supply to Japan of tools for the manufacture of steel shells for the MG-131. There is no evidence of the shipment to Japan of plans or tools as provided for in the above agreements or contract.

<u>MG-151/15 (15 mm)</u>:

In March 42, Army representatives in Berlin made inquiries as to the possibility of acquisition of manufacturing rights for the 15 mm Mauser MG-151/15. Sample guns and ammunition also were under negotiation. Delivery of the guns and ammunition, it was anticipated, would take six months. Five sample guns and 25,000 rounds of ammunition, together with weapons manuals, were handed over to the Japanese in Germany during the latter half of 1942. Those samples and manuals are believed to have reached the Far East during 1943.

<u>MG-151/20 (20 mm)</u>:

The Japanese Army and Navy showed the greatest interest in the 20 mm Mauser MG-151/20. The Japanese Navy requested three sample guns in February 42. During

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the following month, the Army acquired details of the cost of sample guns and ammunition and of manufacturing rights. In April, Army representatives in Berlin studied the use of the MG-151/20 in German aircraft, while three months later they had arranged that the Japanese Army was to be supplied with 2,000 guns at the rate of 400 per month. German Air Ministry records show that during the latter half of 1942 clearance was given for the supply to Japan of 2,000 guns and more than two million rounds of ammunition. Of those quantities, five guns and 35,000 rounds of ammunition were delivered to the Japanese in Germany before the end of 1942.

In December of that year the Army had arranged that the 2,000 guns--of which 100 already had been acquired--and one million rounds of ammunition were to be shipped in the near future. Although transportation was scheduled for January 43, it was not until April that 800 guns and 400,000 rounds of ammunition were loaded on a blockade runner, which successfully reached the Far East. Some of the sample MG-151/20's have been found installed in the Tony single-engined fighter; they were supplied only with mechanically detonated German ammunition. As of mid-September 44, two million rounds of ammunition--

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an additional order made at the beginning of 1944--were at a German Army depot awaiting shipment to Japan. Their delivery to the Far East, therefore, is very unlikely.

At the end of March 43, because of the growing needs of the GAF, it was becoming difficult for the Japanese Army to place any more large scale orders for guns and ammunition, and acquisition of manufacturing rights was considered; in mid-April it was decided not to acquire rights.

Apparently because of the previously reported difficulty of acquiring further guns and ammunition, the Japanese Army in February 44 again considered the purchase of manufacturing rights for the 20 mm ammunition in order to become self-sufficient, now that large imports from Germany no longer were possible. In the following June, information regarding German methods of manufacturing the ammunition was obtained together with drawings and other data. Some of those drawings and data may have been shipped during the summer of 1944. There is no indication of conclusion of an agreement for the necessary manufacturing rights. According to a German P/W, Japanese representatives, in October 44, inspected the manufacture of 20 mm ammunition at a factory in Posen, and paid

particular interest to the machine tools used in the process.

Electric detonating caps for MG-151/15 and MG-151/20 ammunition:

In the spring of 1943 the Japanese Army began negotiations for purchase of manufacturing rights for electric detonating caps for 15 mm and 20 mm ammunition. In June, the German Air Ministry gave Rheinmetall-Borsig approval for the negotiations, pointing out to the company that, in accordance with direction of the High Command, manufacturing data was to be delivered prior to the conclusion of an agreement. The following month approval was given for the sale to Japan, for shipment by mid-August, of 1,000 sample detonating caps. Although by September 43 it was reported that the Japanese Naval representatives in Berlin also were anxious to acquire manufacturing rights, and although the Navy continued to show interest in the process, there is no evidence that the Navy ever concluded an agreement.

The Army also entered into negotiations for large numbers of sample caps. In late September 43, the German Air Ministry authorized the sale to Japan of eight million caps, providing that German needs were

not thereby impaired. Shipment apparently was delayed. In March 44, the Japanese requested delivery of as large a proportion as possible of the 50,000 caps which had been released. In the following May, authority was given for shipment of 28,100 caps. Those caps were still held by the manufacturer in mid-September 44; shipment to Japan probably was not made. The Japanese received only a very small fraction of the eight million caps on order. German Air Ministry records show that one shipment of 10,000 samples was lost in transit in 1944.

In the meantime, manufacturing techniques were under discussion. Army representatives in Berlin in mid-October 43 planned to forward details of detonating-cap manufacture, but, because of security reasons, the German Air Ministry would not grant the necessary permission; Navy and Army technicians in November 43 visited a number of German plants in order to determine the possibility and expense of manufacturing in Japan. The signing of an agreement and the forwarding of detailed plans was delayed until mid-1944. The plans may have been shipped in the summer of 1944.

In June 44, the German Air Ministry released to the Japanese chemicals necessary for the manufacture

of primers for 50,000 detonating caps. According to German Air Ministry records, material for 50,000 caps, presumably the chemicals in question, were still at the manufacturers in mid-September 44; in January 45, the Army repeated their request for the necessary chemicals. Although release was granted, in view of the date, it is unlikely that the chemicals were shipped to the Far East.

MG FF (20 mm):

This Oerlikon 20 mm gun was superseded in the GAF by the MG-151/20. By June 43, however, the Japanese had been granted a license for its manufacture. There is no evidence of Japanese negotiations for, and shipment of, sample guns.

The Type 99 20 mm gun used in Japanese naval aircraft, however, reportedly is derived from the Oerlikon gun. The Japanese, like the Germans, used the Swiss design and were in production with this Swiss design by 1940.

MK-103 and MK-108 (30 mm):

In March 43, Army officials in Berlin were negotiating for one MK-103 30 mm gun and in late May, they hoped to purchase five MK-108 and 10,000 rounds of

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ammunition. In mid-July, the Japanese had renewed an urgent request for delivery of at least one sample MK-108, even though damaged. As of December 43, however, neither an intact nor a damaged specimen could be released, since the gun was not yet ready for use in combat. A German Air Ministry letter of 20 July 43 stated that five MK-103 and ten MK-108, together with 10,000 rounds of ammunition for the latter, were on order; the letter added, however, that delivery was to be put off, as far as possible, until the winter.

In the spring of 1944, the GAF presented, as a gift, two MK-108's and sample ammunition to the Japanese Navy. Thereafter both Army and Navy became active in negotiations for further guns and ammunition, and in June 44 the Army and Navy jointly were negotiating with the GAF for purchase of two MK-103's and some 2,000 rounds of ammunition. Four sample MK-103's and two MK-108's were handed over to Japanese representatives in Germany in July 44; one MK-108 and 25 cases of ammunition were captured on the U-234. The other sample MK-108 and the four MK-103's may have been sunk en route to Japan. In mid-September 44, two MK-108's and four MK-103's were at the Naval Stores at Wilhelmshaven awaiting shipment. Orders

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for a further four MK-103's and two MK-108's were not fulfilled by the German Air Ministry until January 45.

Japanese Army representatives meantime carried on negotiations for manufacturing rights. In September 43, they requested shipment to Japan of drawings for the MK-103 and MK-108, together with prototype guns and ammunition. Manufacturing methods previously had been learned in early June. As of December 43, negotiations were being delayed because the guns had not reached the operational stage. In July 44, the Japanese formally decided to purchase manufacturing rights for the MK-108. Although there is no evidence of conclusion of an agreement for manufacturing rights, drawings for the MK-108 were on board the U-234.

Because a high level of mass production of 30 mm ammunition had not been attained in Japan by July 44, the Army began negotiations for production techniques and machinery. It is believed that sufficient descriptive information possibly reached Japan to provide a basis for improvement of Japanese production, even though manufacturing drawings were not received. Sample ammunition for the MK-108 may have reached Japan early in 1944. Other ammunition was available for shipment in the summer of

that year; some of that ammunition was on the U-234, while some was still in storage at Kiel as of April 45. It seems doubtful that Japan received any ammunition further to that which may have arrived in early 1944.

<u>37 mm Gun</u>:

Early in 1942 the Japanese requested ten 37 mm guns; one year later representatives in Berlin obtained information on methods of manufacture of that gun, a converted Flak 18 mounted in the nose of the JU-87 D for ground-attack operations. In September 43, Japan was considering purchasing a sample of, or manufacturing rights for, the 37 mm gun. There is no indication, however, of negotiations for manufacturing rights. Samples of 37 mm ammunition were purchased by Japan; they may, however, have been for antiaircraft purposes.

<u>BK-5 (50 mm)</u>:

In late February 42, Army representatives in Berlin received specifications for this weapon, an antitank gun which the Germans had converted for mounting in the nose of the ME-410. The gun was further described to both Army and Navy representatives at the end of May 44 in an official explanation by the German Air Ministry. Two

weeks later the Army had placed an order for a sample gun, while the Navy apparently wished to await the results of GAF experimentation and trial manufacture before placing an order. In December 44, Army and Navy representatives visited the GAF station at Posen and inspected the fitting of a 50 mm gun in the ME-410 and its construction and mechanism. There is no evidence that the Army ever received the sample gun; nor is there any indication that the Japanese knew of the MK-214 A, a new 50 mm gun developed from the BK-5.

<u>75 mm Antitank gun</u>:

In early 1942, when the Japanese Navy obtained information on the 50 mm gun in the ME-410, they also learned of an experimental antitank gun under development by the GAF. That gun was made up of the barrel of a 75 mm gun with the addition of a loading mechanism of the type used with the 40 mm gun. The experimental gun, mounted in the HS-129, was claimed to have achieved good results. Plans and samples of the ground 75 mm Model 41 antitank gun reached Japan in July 43.

<u>Aircraft armament from Italy</u>:

In late 1943, Japan became greatly interested in certain guns which the Ansaldo Company was producing for

mounting in aircraft. Negotiations were begun for purchase of sample equipment and plans. Difficulties were encountered and it was not until late October 44 that negotiations finally were completed. However, in March 45, arrangements were in hand to make photographic copies of the plans and documents received from the Ansaldo Company. It is unlikely that either plans, documents or sample equipment ever were shipped to Japan. The weapons for which contracts were negotiated were the 47 mm, 102 mm, and 152 mm aircraft-mounted guns.

<u>a</u>. <u>47 mm gun</u>: First available evidence of Japanese awareness of this gun--used for ground-attack operations--dates from late 1943. Following examination of a descriptive outline of the 47 mm gun and its characteristics, procurement of plans and sample equipment was decided. A contract with Ansaldo, signed in October 44, provided for delivery to the Japanese of a sample gun and equipment, plans and descriptive material. While this material probably reached Berlin in late 1944, it had not been shipped to Japan as of early March 45; delivery to the Far East, therefore, is very unlikely.

<u>b</u>. <u>102 mm and 152 mm guns</u>: Negotiations for these two guns closely paralleled those for the 47 mm gun.

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A contract with Ansaldo, signed in October 44, provided for delivery of sample guns, ammunition, plans and descriptive material; it is unlikely that this material was shipped to the Far East.

Gun mounts, remote control gear and gunsights:

In 1942-43, the Japanese Army purchased, and shipped to Japan, samples of the fixed mount for the MG-151/20, as used on the FW-190; in December 42, photographs of that gun mount were obtained. According to captured German Air Ministry records, by 1 June 43, actual delivery of--or the necessary clearance for delivery--had been made for a number of fixed and flexible gun mounts for the MG-17, MG-131, MG-151 and MG-FF.

Models of the 13 mm remote-control gun mounts used in the ME-210 reached Japan by surface vessel in early 1943. In July 44, however, the Army began negotiations for the acquisition of parts, plans and specifications of a new model remote-control mount, and was studying its manufacture. This may have been the type "GA" 13 mm mount, modification WL-131. There is no evidence that drawings for the new-type mount ever reached Japan; however, certain technicians had studied the mount and

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are believed to have returned to Japan.

About September 44 the Navy collected information on a number of German remote-control gun mounts, gun turrets and gun sights. Apparata covered were the MG-151 dorsal and ventral gun mounts of the HE-177, the MG-131 tail gun of the JU-388 used in conjunction with the PVE-11 periscopic sight and the FA-15 oil pressure remote-control device manufactured by Junkers for use with tail gun mounts.

In October 44 the Japanese Army placed orders for sample JU-388 gun mounts, ten tail guns, four dorsal and four ventral mounts; orders were placed at the same time for 10 sample FA-15 remote-control equipment and negotiations opened for purchase of manufacturing rights. Samples and drawings for the PVE-11 periscopic sight also were requested. By mid-January 45, Army representatives in Berlin had obtained samples of, and manufacturing rights for, the JU-388 tail-gun mount (FHL 131-Z) and FA-15 remote-control equipment. Three FHL 131-Z and three sets of the FA-15 equipment are said to have been shipped and sunk; manufacturing drawings also may have been shipped and sunk. There is no information as to delivery of drawings for the PVE-11 periscopic sight.

There is little available evidence of Japanese interest in German optical gunsights. In late October 41, Army representatives were in a position to obtain a sample Revi-12 C gunsight within a month. It is possible that the sample arrived in the Far East.

<u>Rocket armament</u>:

The Japanese have shown a certain skill in individual development of solid rocket propellants. Rocket-firing fighters also reportedly have been encountered over Japan. The extent of knowledge, and samples, of German rocket armament acquired by Japan is, therefore, of some interest.

<u>a</u>. <u>21 cm rocket</u>: This rocket, used by the Germans as an anti-bomber weapon, was an adaptation of the 21 cm rocket mortar. About April 44 the GAF presented the Japanese Navy with certain equipment, including a complete set of 21 cm rocket projectiles and wing launching equipment. That material was to be shipped to Japan at the first opportunity. The rockets were said to have been shipped and sunk before reaching Japan in the summer of 1944. Navy representatives in Berlin obtained considerable detail on the 21 cm rocket in April 44.

b. Panzerschreck: This 88 mm rocket projectile was a German adaptation for aircraft use of the 88 mm antitank rocket, and was designed for low-level attacks on armored vehicles. The land armament version of the Panzerschreck was the subject of an agreement for the purchase of manufacturing rights in February 45. At least one sample was on board the U-234. There is no available evidence that the Japanese had any interest in the aircraft-launched version. However, in early 1945 the Japanese Army reportedly was using an aircraft-launched 87 mm rocket which is reminiscent of the Panzerschreck; two rockets were carried under each wing.

c. Panzerblitz: The airborne version of the Panzerschreck was replaced, in the GAF, by the lighter 8 cm Panzerblitz; an FW-190 could carry twelve Panzerblitz as opposed to only six Panzerschreck. In March 45, Naval representatives in Berlin obtained information on the GAF's use of the Panzerblitz. There is no further evidence regarding Japanese knowledge of the weapon.

Bomb-torpedo:

In October 44, the GAF gave to Japanese Army and Navy representatives information on the bomb-torpedo,

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a weapon intended for aircraft attacks on shipping. Released from the attacking fighter-type aircraft like a bomb, the weapon was to produce an underwater explosion in the manner of a torpedo. Detailed information was obtained on the weapon--of which there are four sizes weighing respectively 440, 880, 1540 and 2860 lbs. Drawings of the bomb-torpedo were requested; in early February, an explanatory document already had been microfilmed and sent by submarine. According to captured German personnel, Japanese representatives were instructed in techniques of bomb-torpedo attack using the TSA bombsight, and were given written material. The personnel expressed the opinion that copying of the bomb-torpedo was within Japanese capabilities.

Glider bombs and guided missiles:

a. HS-293: The first available evidence of Japanese knowledge of the HS-293 radio-controlled rocket-propelled glider bomb for attacking light naval vessels and merchant ships is contained in a captured file, which contains a 24 February 44 report from Vice Admiral Abe to Tokyo. That report described a conference with the Chief of the German Air Staff, at which films of the

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HS-293 and FX bombs were shown to Abe and other Japanese representatives. Abe's report gave outlines of construction and specifications, but contained no detailed information. In late June 44, Naval representatives in Berlin were given data on the HS-293 A. The weapon apparently greatly interested the Japanese who wished to obtain production sketches, manufacturing rights and technicians. In September, Japanese Army and Navy representatives visited Garz/Usedom to attend a demonstration of the HS-293. There is no evidence that prototypes, drawings or manufacturing rights ever were acquired by the Japanese representatives in Germany.

b. FX bomb: On the occasion of the September 44 visit to Garz/Usedom, the Japanese representatives were allowed to inspect the FX-1400 rocket-propelled bomb for attacks on major naval units, and which was used to sink the Italian battleship "Roma". The Garz/Usedom visit produced details of weights, dimensions, construction, bomb release and control in flight for the FX; the representatives apparently also saw films of a trial release. Additional information on the FX was obtained in October 44. There is no evidence that any drawings of the FX ever arrived in the Far East.

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c. HS-294, HS-295: Available information on Japanese knowledge on these larger versions of the HS-293 is very scanty. The Japanese were informed about December 44 of the existence of both weapons. According to Dr. Wagner, inventor of these weapons and of the HS-293, it was intended that he should hold discussions on the HS-294 with Japanese representatives in December 44. The discussions were postponed and never took place. There is no evidence that any other information on the HS-294 and HS-295 was sent to Japan.

d. Guided missiles: There is little evidence of information on the newer German guided missiles having been sent to Japan. In fact, it appears that the Japanese were kept in the dark as to the existence of those missiles.

e. BV-246: This glider-bomb was included in the equipment presented by the GAF to the Japanese Navy in April 44; at that time the weapon had not been used operationally. Plans, an experimental report and descriptive text for the glider-bomb were shipped and probably sunk.

BP-20 (Natter):

Personnel of the manufacturing firm stated that they were ordered to give complete details of the BP-20 to

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Japanese representatives in Germany. Although, because of transport difficulties, the Japanese never received those details, the manufacturing personnel stated that the Japanese had a general knowledge of the interceptor and its purpose, and showed considerable interest in the project. It is possible, therefore, that some information on the BP-20 was sent to Japan; it is extremely unlikely that any plans or samples were shipped to the Far East.

<u>Bombs</u>:

In 1941-42 Japanese Army and Navy representatives in Germany purchased, and shipped to Japan, samples of a wide variety of German bombs, including samples of the 1,000, 1,400 and 1,700 kg bombs. The Navy also was to purchase samples of the 2 kg ground-attack bombs; according to German Air Ministry records, 500 samples of the 2 kg bomb were released for delivery to Japan during the latter half of 1942. During that period, the GAF offered to Japan, for immediate delivery, 600 or more sample bombs; by late March 43 a large number of sample bombs had been purchased and loaded for shipment. A further shipment of bombs--including incendiary and normal and thin-case high-explosive types--and fuses

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was purchased from Rheinmetall-Borsig and shipped in August 43. It is probable that most or all of the bombs and fuses shipped to the Far East arrived safely in Japan.

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Aircraft Equipment

Aerial cameras and lenses:

As early as 1941 the Japanese were purchasing samples of aerial cameras in use by the GAF; purchases were continued through the subsequent years. Up to the spring of 1943, when the Germans apparently standardized their out-put to produce only cameras of 50 cm aperture, cameras with aperture of 20 cms and 75 cms respectively had been purchased and a total of 100 samples sent to Japan. By the late summer of 1943 the Germans had failed to produce cameras with 50 cm aperture for the Japanese; presumably for that reason Japanese purchases continued to be of the earlier type camera. Special lenses, and parts and accessories for cameras, all were negotiated for concurrently with the cameras themselves. During the more recent negotiations there was an apparent tendency to purchase and ship lenses, rather than complete cameras. Presumably because of a reported shortage of optical glass in Japan, manufacturing rights for few aerial cameras were purchased. The only known cases of purchase of manufacturing rights were Italian-made aerial cameras. Drawings of those cameras were shipped and sunk.

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High altitude pressure cabin:

As early as February 42, when Germany offered the rights for the Henschel pressurized cabin, the Japanese Army and Navy became interested in high altitude flying equipment. The Japanese Navy is known to have acquired rights to manufacture a pressurized cockpit--which may have been an early Henschel model--within three months of the German offer. Drawings for the HS-130 pressurized cabin were dispatched to Japan. Apparently, however, the drawings were not complete enough to allow of reproduction in Japan; parts and plans again were shipped in the spring of 1944, probably on two U-boats, both of which are thought to have been sunk before reaching Japan. In August 44, the Japanese Navy again requested the shipping of parts and drawings for a pressurized cabin. Those parts and drawings may have been shipped sometime during the summer of 1944. In July 44, the Japanese Navy acquired manufacturing rights for a Henschel pressurized cabin, probably a later model than that for which rights were acquired in 1942. According to U.S. Navy reports, experimental high-altitude pressurized cabin cells have been found among equipment at the Yokosuka Naval Air Experimental Station.

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Automatic pilots:

By mid-1941 the Tokyo Aircraft Gauge Company is believed to have acquired patent rights for the Askania automatic pilot; the agreement provided for two Japanese technicians to work at the Askania factory. In early 1942 the Japanese apparently were negotiating for a Siemens automatic pilot and required data necessary for its large-scale construction in Japan. By the end of March 42 attempts also were being made to obtain manufacturing rights for the Patin automatic pilot.

Negotiations with the three German companies for manufacturing rights apparently continued throughout 1942. It appears that the Patin triaxial automatic pilot was selected as being the best instrument. It was not, however, until late October 1944 that manufacturing rights for, and ten samples of, the Patin automatic pilot were requested. Negotiations were concluded early in November 44 and steps for immediate purchase of several sample equipments were put in hand. According to German Air Ministry records, manufacturing plans for the K-12 automatic pilot were still in the hands of the manufacturer as of mid-September 44; there is no evidence of their shipment to the Far East.

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Propellers:

During 1940-41 the Japanese negotiated for purchase of manufacturing rights for the VS-5 variable pitch propeller manufactured by the Junkers Company. Japanese technicians arrived in Berlin in mid-1941 to conclude negotiations with respect to that propeller. On arrival, it was found that an improved design, the VS-11, already was in production and that the earlier model was obsolete. Negotiations, therefore, were switched to the new type propeller, and attempts made to buy samples, plans and machinery and arrange for their immediate shipment to the Far East. By the end of 1941, manufacturing rights were being acquired; arrangements were in hand by April 42 for shipment of plans, lists of materials, and one complete propeller. This material undoubtedly arrived in the Far East. An agreement was also concluded for manufacturing rights for Schwartz propellers, drawings and prototypes. Production of the Junkers and Schwartz propellers in the Far East apparently was to be undertaken by Nihon Gakki, manufacturers of wooden airscrews.

In early 1944, the Army was also very anxious to obtain plans for the Messerschmitt MP-6 propeller and negotiations apparently were in hand. There is no

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available evidence as to the results of those negotiations.

Aircraft catapult:

German Air Ministry records indicate that the Japanese representatives in Germany purchased, probably in 1943, one sample drum-type aircraft catapult, type KL-12. As of August 44, that sample was still at the manufacturing firm, although ready for shipment. At that time there was no possibility of transporting the catapult, which was intended for the Japanese Navy. The equipment, therefore, was to be placed in storage; it is very unlikely that it was shipped at any later date. Manufacturing rights were purchased in July 44; plans had been received the previous month, and were scheduled for shipment to the Far East in September. It is unlikely that they ever reached Japan.

Assisted take-off equipment:

In 1943 the Japanese Army purchased five sets of the assisted take-off apparatus as used on the JU-88. According to German Air Ministry records, assisted take-off apparatus, including containers and transportation boxes, was shipped on 30 September from Germany to Bordeaux for onward transportation to the Far East. There is no

evidence of shipment of the equipment to the Far East; it is possible, however, that such transportation may have been carried out.

Lotfe bomb sights:

From 1941 on, the Japanese made continual inquiries concerning Lotfe bomb sights, learned the details of German production methods and obtained many samples. They tried for a time to manufacture their own sights in Japan but after a short while gave up that idea and began placing new orders with firms in Germany.

German recommendations for the Lotfe bomb sight (subtype not specified) began in 1941, and on 29 October of that year Japan was informed that a Lotfe 7C was available for delivery. Japanese military representatives purchased a sample bomb sight (the 7C) in March 42, but delivery was held up.

In March 1943, Army representatives obtained information on the Lotfe 7D. Clearance for delivery of 300 Lotfe 7C's to the Japanese had been given during the latter half of 1942. Prototypes and blueprints for the Lotfe 7D are known to have reached Japan in 1943. Both Army and Navy Attachés decided that, from an engineering

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standpoint, the 7D could not be manufactured in Japan.

During 1944 the Lotfe 7H was investigated. Japanese Army and Navy representatives made a tour of inspection through the Zeiss factory at Saalfeld.

A German Air Ministry document dated 13 April 44 approved delivery to Japan of 50 Lotfe 7D's per month; another document granted permission to Karl Zeiss for the sale of 300 type 7D's. By June 1944, Japan had decided that manufacturing rights were unnecessary. Either production was found impossible, or because of difficulties involved, it was decided to continue ordering from German manufacturers. Reordering from Germany began late in 1944 but was not entirely satisfactory; German Air Ministry records show that of 300 type 7D bombsights ordered in June 1944, none had been delivered as of the following December. German Air Ministry records also show that 300 7D's were to be available for delivery in January 1945 and thirteen 7H sights were awaiting shipment at Kiel. Several 7D's had been left behind at Bordeaux early in 1944.

<u>TSA-2 dive bomb sight</u>:

In July 44 Japanese Army representatives requested that Germany release manufacturing rights for a dive-bomb

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automatic sight device. Apparently the TSA-2 and BZA-1C types were investigated and considered; in November Army representatives in Berlin negotiated to purchase the manufacturing rights for the TSA-2 type but stated that the BZA-1C type was not needed. By the end of December 44 the manufacturing rights for the TSA-2 had been acquired, possibly for use with the bomb-torpedo. Manufacturing rights were released to the Japanese Army by the German Air Ministry during January 45. According to a note in Kobayashi's notebook, C. Illies and Co. listed among deliveries in preparation in 1945, license rights for the Zeiss bomb sight and five sample TSA-2's.

Although the Japanese possess manufacturing rights and production specifications, there is some doubt that they could have copied and used the TSA-2. According to Zeiss' chief bombsight engineer, that firm, on instructions from higher authority, gave to Japanese representatives in Germany a sample of the TSA computer, which takes the altitude, air speed, and dive-angle, and computes and solves the slant-range problem. The computer never was used in combat by the Germans.

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Parachutes:

In early 1945, Naval representatives in Germany learned details of new German high-speed parachutes. Negotiations for purchase of several sample parachutes and of manufacturing rights were to be initiated within the near future. There is no evidence to indicate conclusion of the negotiations; in any event, in view of the date, shipment to Japan of any samples or plans is considered very unlikely.

Parachute brake:

By late July 43, purchase of a sample of the parachute tail-brake, as used on the JU-88, was being negotiated. Although a German Air Ministry document, dated August 43, stated that special importance was attached to release of the JU-88 type parachute brake, sample equipment still was at Kiel awaiting shipment in April 45. It is believed that there had not been any previous shipment of sample equipment.

Bullet-proof fuel tanks:

In March 42, Army representatives in Berlin inspected the German bullet-proof fuel tank; the German Air Ministry was being requested to authorize transfer

to Japan of sample tanks to allow of their use with the DO-217 and ME-210. There is no evidence to indicate that sample tanks were obtained. German aircraft fuel tanks were the subject of further inquiry in December 43, which suggests that the earlier negotiations had not been successful.

Fuel injection pumps:

In August 42, the Germans offered to the Japanese, for immediate delivery, two sample fuel injection pumps as used in the BMW-801. Those pumps were shipped by the end of July 43, as also were two sample fuel injection pumps for the Jumo-211; one of the latter was sunk en route. The only other German fuel injection pump in which the Japanese showed interest was a pump designed by Henschel for the BMW-003 turbo-jet unit, which, because of its small size and simple construction, reportedly was suitable not only for turbo-jet units but also as a high-pressure pump for all types of equipment.

Oxygen masks:

In late 1941, the Army was in a position to procure three Kerubin type oxygen masks; by April 42 these had been purchased and arrangements for their shipment

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were in hand. The masks may have reached the Far East. In early 1942 negotiations were started for purchase of three sample oxygen masks of the Auer type; these were cleared for release to Japan during the latter half of 1942 but are believed to have been sunk en route to the Far East.

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SECTION III

ELECTRONICS

__Note:__ Brief descriptions of the equipment discussed in Section III are contained in TAB H.

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ELECTRONICS

Introduction:

Japan's interest in acquiring technical assistance from Germany in respect to radar and radio equipment was exceeded only by her interest in German aircraft.

The Japanese looked to Germany for general technical assistance in electronic development but were not as interested in acquiring manufacturing plans and drawings as was the case in other directions. A possible explanation of this may have been that the Japanese were planning adoption of radar and radio equipment on independent lines and proposed embodying German and Allied features rather than the complete adoption of German techniques.

The development of electronics in Japan was in the hands of Army and Navy experimental establishments, universities, and the industries and this diversity of research does not appear to have operated smoothly.

Technical development centered at the Tama Military Technical Laboratory, and other laboratories at Okayama, Ikuta, Kawasaki, Mitaka, Tsukaguchi and Sendai while Fuji Denki K.K., Nihon Musen Denshin K.K. and Mitsubishi Denki K.K. featured as major producers of electronic

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apparatus and tubes.

Research and development apparently was not guided by any central authority and, in general, Japanese technical skill did not develop to the state where independent research produced original electronic equipment. In fact, at the beginning of the war, Japan was far behind the Allies and Germany in the production of electronic equipment and was forced to rely on Germany--to an extent not evident in other categories of war material--for assistance in acquiring German and Allied material for development of her own apparatus.

The Germans provided technical help by delivering prototypes of their own equipment and tubes to the Japanese but did so--at least up to the final stages of the war--only for material known to be in Allied hands. Captured specimens of Allied equipment also were obtained by the Japanese in Germany.

Various Japanese radar and radio technicians were permitted to study German equipment and are known to have visited the German Radar and Infra-red Experimental and Testing Station at Heiligensee, where they obtained blueprints of German electronic installations.

A German P/W states that blueprints definitely

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were handed over to the Japanese during the period from 1942 to 1944 for:

Würzburg C	1942
Würzburg D	1942
Würzburg Riese	1943
Mannheim 41 T	1943
Dreh-Freya	1943
Fahrstuhl-Freya	1943
Nürnberg	1944
Würzlaus	1944
Taunus	1944
Wismar	1944

In 1943, German technicians, Marine Obering, Steiker and a Gema radar engineer--probably Brinker who is believed to have arrived in the Far East in July/August 43--were sent to Japan. They carried with them complete plans for the Würzberg Riese, a radar intercept receiver "Athos" in the 9-3 cm wave band and plans for German submarines. Those technicians are reported to have had little success in improving Japanese electronics equipment.

Another technician, Heinrich Foders of Telefunken, who arrived in Japan in the late summer of 1943 for the purpose of studying Japanese radar equipment and improving it with German production techniques, in October 44 adversely reported on the Japanese radar industry, particularly on deficiencies in tube production, laboratory test apparatus, and ultra high-frequency insulation materials. Foders stated

that there was no coordination of effort between interested parties, that the principal wave lengths of Japanese radar were above 80 cms, except for two experimental sets of 20-25 cms, and that only one model--a naval shipborne set--had reached the stage of mass production.

Other technicians connected with radar development were on the way to Japan at the end of the European war. At that late stage, Japanese anxiety to obtain technical assistance from Germany is proof of the difficulties they were meeting in producing adequate electronics equipment.

Towards the end of the war, the Germans were more willing to divulge complete information on radar developments. According to Capt. Schuler, German electronics director, the Japanese were familiar with all ground search radar employed by the Germans. They were also acquainted with British 3 cm equipment. Generally, it may be assumed that Japanese technicians in Germany had been fully informed on all recent German research in the high frequency field.

The German technicians with whom the Japanese officials worked have expressed the opinion that, provided information collected in Germany reached Japan--which in many instances is very doubtful--the Japanese obtained, through Germal liaison, a very thorough grounding in

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electronic research and production.

Listed below are details of the negotiations between Japan and Germany for purchase of electronic equipment.

Radar--Ground and shipborne:

Würzburg: Initial interest in German Würzburg dates from October 42 when blueprints of the A, C and D models are believed to have been obtained in Germany and sent to Japan. Drawings for the Würzburg-D are thought to have reached Japan by June 43 at the latest. Copies of blueprints for Würzburg Riese were said to have been taken to Japan by Engineers Brinker and Steiker, who reportedly arrived in the Far East in August 43.

As early as February 43 three mobile Würzburg D's had been acquired by the Army and may have been immediately shipped from Europe by surface blockade runner. After initial study, the Japanese applied, in May 43, for release of 100 Würzburg D, of which 50 were for the Army and 50 for the Navy; the Germans agreed to deliver 15 sets monthly, beginning January 44. In addition to the 100 complete sets required, the Japanese requested supply of 200 sets of components, though this demand was later reduced to 100 sets of components.

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German agreement to the release of equipment did not, of necessity, mean delivery to Tokyo; it is believed that various sets actually loaded for shipment to Japan were lost. However, it is probable that a few sets of Würzburg D reached Japan in 1943 and several may have arrived in 1944.

Initially, the Germans refused to release to Japan AB grids, Michael, Eidechse, and Goldammer components; release of AB grids and Michael subsequently was approved.

About August 43, Japan decided to purchases manufacturing rights for Würzburg D. Details of the negotiations are not available but on 6 July 44 those rights were acquired by the Navy. It is improbable that full blueprints ever reached Japan. A letter from the Navy to Telefunken, and captured on the U-234, states that all manufacturing drawings for Würzburg D had been received. Receipt by the Navy representatives in Germany probably is implied. In October 44, Foders reported that mass production of the German Würzburg D had not begun at that time and generally implied that Japanese efforts to develop radar manufacture were very disappointing. According to Foders' report, the Japanese were handicapped by a shortage of trained engineers

and special mechanics, laboratory test apparatus and high grade insulating materials for ultra high frequency.

Siemens searchlight control equipment: Manufacturing rights for Siemens searchlight control gear for use with Würzburg were acquired in September 44. The equipment concerned is believed to have been a tri-axial control apparatus, Model G150 D. It is thought that blueprints and models never reached Japan.

Freya: In March 43, the Germans authorized the release of Freya and appropriate manufacturing data to the Japanese Navy. That material was to be taken to Japan by Brinker, who was to set up plants in Japan for the manufacture of radar equipemnt for the Navy. However, limited submarine space prevented loading of the Freya apparatus and there is definite evidence that two sets of Freya were still in the hands of the German manufacturers in January 45. Plans for Freya (Dreh Freya, Fahrstuhl Freya and Freya LZ) were delivered to the Japanese representatives in Germany in 1944, and may possibly have reached Japan.

Freya components--2 amplifier generators for Riese Gerät, 2 receivers, 2 visual indicators and 2 synchronizing sets--also were released but probably not shipped.

<u>Mammut and Mammut G:</u> The Japanese received descriptive data on Mammut and Mammut G, but there is no evidence of any desire to obtain prototypes or plans.

<u>Seetakt (FuMO 1, FuMO 40G)</u>: Manufacturing rights for the Gema Company's Seetakt were acquired by the Japanese Navy in July 44. The U-234, when captured, carried copies of the agreement between the Navy and Gema for manufacture of Seetakt. It is not believed that prototypes or drawings have reached Japan.

<u>Hohentwiel S (FuMO 63, FuG 200)</u>: The U-234 carried a contract between the Navy and Illies and Co. for a set of parts for FuMO 63. In March 44 the Japanese Army received descriptive data on the FuG 200, which set is adaptable to either air or shipborn use.

<u>FuMO Anlage 51 (Refer FuG 200 Hohentwiel)</u>: These sets were purchased through naval channels and were probably intended for use by the Japanese Navy either as air, surface vessel or submarine search redeivers. It is not believed that models reached Japan.

<u>FMG 41T or Fu SE 64 Mannheim</u>: Captured personnel from Heiligensee have stated that the Japanese obtained blue-

prints of Mannheim in 1943; however, there is no evidence that they reached Japan.

Airborne radar and I.F.F.:

FuG 200 Hohentwiel (See ground and shipborne radar): In April 44 the Germans agreed to release one set of Hohentwiel to the Japanese to replace FuG 213, which had gone out of production. Later the Germans agreed to supply three sets monthly, against an initial request of five. Photographs, plans and explanatory data were also requested by Japan, but it is not known whether they were delivered.

FuG 202 (FuMO 71) Lichtenstein: The first order for FuG 202 was made in April 43; in May 44, following German agreement to release that apparatus, the Japanese Army Air Force requested delivery of 30 sets. FuG 202 was offered in place of FuG 212 which previously had been requested. Delivery to the Japanese in Germany of 30 sets of FuG 202 had been effected by October 44, but these probably were never shipped.

FuG 213 (Lichtenstein S): In June 43 the Japanese made application for two sets of FuG 213; release was granted immediately. In September, the Japanese Army and Navy asked for 53 FuG 213 consisting of:

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53 instrument sets
53 installation sets
53 cables and material for assembly

Delivery of that equipment could not be undertaken by the Germans for six months. A renewed application was made in January 44 for 30 sets, with an urgent request for delivery of three sets. Those three sets were released immediately. The Japanese were then informed that production of FuG 213 had ceased; FuG 200 was offered to them instead.

FuG 216A (Neptun V): The only information regarding Japanese interest in this apparatus was its release to them in August 43. No information is available regarding shipment to the Far East.

FuG 224 Panorama (Berlin): Two sets of FuG 224A (Berlin, a 9.1 cm set) were purchased by Japanese representatives, but never left Europe. This set was copied by the Germans from Allied equipment.

FuG 25 and 25A(IFF): Clearance of three FuG 25 was requested in June 43 for the Japanese Army; immediate delivery was approved. In July, the Japanese were advised that the set had been declared obsolete but purchase of five sets was completed and delivery made by June 44. It is believed that those sets were never shipped to Japan.

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In October 44, two sets of FuG 25A were acquired by the Japanese Army, but at a date probably too late for shipment to Japan.

FuG 136: Descriptive data on this set is thought to have been given to Japanese representatives in Germany; it is believed, however, that no data arrived in Japan.

Radio altimeters, navigational aids, blind bombing devices:

FuG 101 (F Gerät): In December 43, one set of the FuG 101 radio altimeter was released to the Japanese Navy for immediate shipment; detail of actual shipment is not on record. Subsequently, in June 44, a further ten sets apparently were made available.

The U-234 carried a contract between the Japanese Navy and LFG Hakenfeld covering supply of five FuG 101 and one test apparatus FuP 101. Five sets of FuG 101 were still at Kiel in April 45, awaiting shipment to Japan.

FuG 102 (Pulse type): In July 43, the Japanese in Berlin requested and obtained permission for realease of two sets FuG 102, but were informed that supply could not be arranged until early 1944. Subsequently the order appears to have been increased to ten sets, of which five

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were released in October 43.

FuG 103: At least one set of FuG 103 is known to have been purchased by Japanese representatives in Germany.

Direction finder (Telefunken) EZ-4 and EZ-6: In January 42, plans were made to transfer to Japan by the following August one hundred sets of the EZ-4 direction finder for short-range fighters, long-range fighters, night-fighters, reconnaissance and dive bombers. Plans were revised in April 43, and, although the Germans would not agree to delivery before July 44, EZ-6 was substituted for EZ-4. Tha Japanese Navy in Berlin endeavored to obtain plans for the EZ-6 in November 43, and, by the end of 1944, were negotiating for a total of 500 sets of EZ-4. Deliveries certainly did not proceed according to plan, although it is possible that a few sets--probably EZ-4--did arrive in Japan.

In November 43, the Japanese Navy endeavored to secure manufacturing rights for EZ-6; it is not known whether they were successful, nor whether plans ever reached Tokyo.

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<u>PeG IV and VI (D/F Homing)</u>: Twenty-four Telefunken Peil IV D/F sets were sold to Japan Air Transport for shipment early in 1943; that delivery probably was for commercial transport purposes. In August 43--and following an order for 40 sets previously released--the Navy requested delivery from Telefunken of eighty additional PeG IV although delivery of the eighty sets was not to be undertaken prior to January 44. Further negotiations appear to have followed for purchase of 2,580 units; although delivery of 60 units per month was agreed upon, that order was cancelled in October 43.

Release of PeG VI was arranged in October 43, but delivery was not possible at that time. Manshu Air Transport Company endeavored to buy 29 PeG VI in April 44; that request was followed in the same month by a Japanese Army demand for 3,000 PeG VI and 135 PeG IV sets.

Delivery never met demand and there is no available information as to shipment.

<u>Radio beacons</u>: The Japanese in Berlin investigated German employment of radio beacons and though release of the equipment was granted, shipment was not made of the complete installations. Because of difficulty of shipment,

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only descriptive data of the aerial were procured.

<u>FuG 302 (Schwan-See)</u>: Release of two sets was agreed for November 43, but delivery was delayed at least until 1944. It is unlikely that specimens of this apparatus ever reached Japan.

<u>Y Gerät</u>: Descriptive information on the Y-Gerät was obtained in November 43; two sets of air-ground equipment were released in May 44. Thirty more sets were required but not supplied because of prior German demand. Due to transport problems it is doubtful whether any apparatus was shipped.

<u>Fu Bl, 2F</u>: The Japanese applied for 100 Lorenz Fu Bl, 2F in December 43 but the Germans were unable to agree to supply more than 8-10 at that time. No further information is available on those negotiations.

<u>X Gerät</u>: Although there is evidence of Japanese special interest in this equipment, the Germans objected to its release on grounds of security.

<u>Adcock assemblies</u>: In June 43, the Germans agreed to supply two KZW (short-wave) and LGW (long-wave) Adcock

installations; mobile type delivery was to be made three to four months later, and stationary type immediately.

Subsequently (November 43) ten sets of the A70b Adcock installation, wave range 2900-11,000 kcs, were released at a rate of 2-3 units per month. There is no information as to shipment to Japan.

Communications equipment:

Airborne radio sets:

FuG 2: Two sets of FuG 2 were available for delivery in January 45, probably too late for shipment to Japan. There is no indication of previous purchases or shipments.

FuG 3a: Two sets of this equipment, with E 502 receiver, were purchased by the Japanese Army from Telefunken in December 44, but were never shipped.

FuG 7a: In January 42, Telegunken offered to supply the Jaoanese with 130 FuG 7a sets (wave length 80-120 meters) but it is not known whether the Japanese were interested in purchasing this equipemnt.

FuG 10: In November 43, two sets of FuG 10

were released to the Japanese Navy and were scheduled for shipment the following month. In July 44, the Army requested five sets of the impulse wave type and five sets of the modulation type, plus photographs, plans and explanatory data. One set of the equipment was found on the U-234.

<u>FuG 15</u>: In April 43, both branches of the Japanese armed forces requested several models of FuG 15. In September 43, it was decided by the German military authorities that this equipment could not be released until the second half of 1944, since development only recently had been completed. Ten sets were again requested in September 44, but none are thought to have been sent to Japan.

<u>FuG 16</u>: Three sets were purchased by the Navy and were available for shipment in August 44, but there is no indication of shipment.

<u>Bolinder receiving sets from Sweden</u>:

In 1944, the Japanese Army acquired manufacturing rights for Bolinder type wireless receivers. The wireless receivers were described as "equally adapted

for use on aircraft, on ships, and on the ground, their special feature being a receiving capacity of 400 words per minute."

Jamming, anti-jamming and countermeasures:

Captured German documents and personnel indicate that the Japanese in Germany received information on Gema radar anti-jamming equipment in the form of blueprints for Würzlaus, Taunus, Nürnberg and Wismar. Stendahl, Aphrodite and Thetis also were described to them. There is further information that in March 43 Germany released to the Japanese two sets of Wismar equipment, which were to be taken to Japan by Brinker; but evidence is not available as to when the sets actually reached their destination. By February 45, the Japanese had bought manufacturing data for Wismar but the plans were lost in transit.

While the Japanese are known to have employed "window" against their own radar for test purposes in connection with experiments to ascertain the best type of "window" for Japanese use, there is little evidence of anti-jamming training of Japanese radar operators. Instances of Allied jamming of Japanese radar have re-

sulted in the Japanese closing down their sets. In general, evidence points to serious deficiencies in Japanese anti-jamming techniques.

Search receivers:

The Japanese are known to have purchased models of the following German search receivers in 1944, but little information is available on their shipment to the Far East:

FuMB Ant.3 (Rundipol)
FuMB 9 (Wanz Anlage)
FuMB 10 (Borkum)
FuMB 26 (Tunis)
FuG 350 (Naxos)
Sadir R 87E and Sadir R 87H.

Allied radar:

The Japanese gained from the Germans considerable information on various types of Allied electronic equipments. The Germans were in a good position to analyze Allied material and adapt it for their own use; such information was usually passed on to the Japanese. In some dases, samples of the equipment itself were given to the Japanese; such was the case with British and American radar identification equipment (IFF), samples of which the Japanese Army received in 1943. The British model was designated R-3002; the American model

was BC-647 A.

Great interest was evidenced by the Japanese in Allied blind-bombing equipment--American "Meddo" (H2X) and British "Rotterdam" (H2S). In 1944, considerable descriptive detail was passed on to the Japanese and models and drawings of Rotterdam and Meddo were purchased. It is not believed that prototypes or drawings either of Rotterdam or Meddo ever reached Japan from Germany. However, in January 45, the Japanese captured a Rotterdam instrument from a downed American B-29. That equipment, together with German descriptions and German trained technicians--particularly Satake--should have been of great assistance to the Japanese in constructing similar equipment.

In March 44 the Japanese Army also became interested in Rosendahl, the German designation for captured British "Monica" (tail-warning radar) equipment. Models and explanatory data were purchased, but it is not known whether this equipment reached Japan.

<u>Miscellaneous electronic equipment</u>:

German P/W's and captured documents--notably German Air Ministry records--made reference to a variety

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of miscellaneous electronic equipment, relative to Japanese inquiries for German equipment. Little detail is available regarding such equipment, particularly in respect of transfer to Japan of either prototypes, drawings or manufacturing rights.

Listed hereunder are the principal items which at one time or another have been discussed between the Germans and Japanese, but regarding which the status of negotiations is very obscure. This list is included to indicate in what directions, other than those noted in the foregoing sections, the Japanese have attempted to fill their electronic requirements from German sources:

FuG 217 (Neptun RII)
FuG 218 (Neptun RIII)
FuMG 404 (Jagdschloss)
Wasserman (Chimney)
Wasserman M
Adler radio-telephone
DMG 4K and 5K decimeter communication
    equipment (Michael)
DMG 3G decimeter communication equipment
    (Rudolph)
AS 59 200 watt transmitter
Powerline TAK 1107 rectifier set 220 V
Power set EM IV (FW 3000 A) motor generator
T 36 40 teletype machine
1.5 Kw. communications transmitter
P 53 N Telefunken D/F receiver
Fu PNG current tester
Rehbock artificial target testing
    device for Würzburg D.

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Ultra-short wave communication sets for armored unit: The Japanese were advised in May 41 of the Bosch communications short-wave unit developed by the Germans for use in armored vehicles and were informed that patent rights could be acquired.

No information in respect of purchase of rights or shipment of prototypes is available. It is possible that this type of set was never adopted as standard equipment in Germany; certainly no set fitting the somewhat loose description has been found on German armored vehicles.

Infra-red:

A significant effort on the part of the Japanese was in the field of infra-red ray searching and sighting equipment. For the most part, their interest was in connection with location and interception of aircraft, presumably because of the slow progress of radar development in Japan. Since infra-red equipment is relatively simple in so far as construction is concerned, it is only natural that the Japanese should have explored this field.

The Japanese Army first made inquiry in Germany for infra-red equipment in 1941, and again in 1943, but

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the Germans were not yet ready at that time to pass on their knowledge to their ally. By June 44, the Army had succeeded in placing an order for 50 "Spanner" infra-red sets, which were scheduled to be delivered by the end of the year. A captured document from the German Air Ministry files indicates that in November 44 two infra-red apparatus "Spanner II A" were to be delivered to the Japanese Army Air Forces. However, in January 45 the order was cancelled and the equipment was never delivered. Thus, it would appear that no samples of German infra-red equipment ever reached Japan; any delivery was made only to Japanese representatives in Germany.

In the spring of 1945, the Japanese made a serious attempt to import raw materials and technical assistance from Germany in order to develop an infra-red program in Japan. One of the passengers on the U-234, which surrendered to the Allies in May, was a Dr. Schlicke, an infra-red expert who was scheduled to assist the Japanese in this field. Included in the cargo of this submarine were 100 kgs of thallium, presumably for use in manufacturing infra-red equipment. Dr. Schlicke stated that the following documents also were on the U-234:

1. Papers describing the exact details and operation of Evaporografie.

2. Complete details of "Linse".

3. Complete details of "Gross Bildwandler".

The Japanese in Germany also were instructed briefly on the following types of equipment in late 1944 and early 1945.

"Seehund III" or "Falter" - a device employing an image converter tube for detection of aircraft.

"Adler" - a large ground-based equipment with longer range capability.

"Flamingo" - a thallium sulphide detector for use on naval craft.

"Kiel" - an airborne interception equipment for night fighters.

"Gartenzaun"and "Zattenzaun" - infra-red absorbent paints for use on submarines and other naval naval vessels. Samples of the paint were also obtained.

In November 44, the Japanese received a description of the process for manufacturing the cathode and phosphorescent screen of image converter tubes. Although the data presented was unusually detailed, it

is believed that the absence of drawings, of specifications for parts and materials, and of trained technicians would make actual reproduction of the tube in Japan impossible. However, such data might be useful in improving the quality of tubes already in production in Japan.

Vacuum tubes:

Direct purchases: The Japanese Army and Navy began negotiations for German vacuum tubes as early as 1941. In 1942, the Japanese Army is known to have purchased small quantities of the following tubes, some of which undoubtedly reached Japan in 1942 or 1943:

LS-180
LD-1
LD-2
LG-1
RD-12-TF
MS-50-14 R magnetrons

Unspecified types of Würzburg vacuum tubes and drawings were purchased by the Japanese Army in 1943 along with samples of Würzburg sets. The Würzburg tubes are thought to have reached Japan in early 1944, but were damaged in transit and were probably of no great value.

In addition to the tubes listed above, a captured Japanese document indicates that other German

Telefunken tubes had reached Japan sometime before 30 November 43 and had been tested in the Tama Military Technical Laboratory near Tokyo, and in the Ikuta, Okayama, Kawasaki, Mitaka, Tsukaguchi and Sendai laboratories. Those tubes included the following:

LS-3
SA-100
SA-102
RV12H300
RV2.4P3
RV2.4T3
RV2.4P1400
RL2.4T4
RL4.8P15
LS-30
RS-393
RL12P50
RS-383
RG-62
RD-4 Ma Magnetrons

Many NF-2 tubes made by Telefunken in Germany have been recovered in Japanese equipment and in supply depots, indicating that Telefunken at some time supplied a considerable number of those tubes to Japan, although no record of the negotiations is available.

In the summer and fall of 1944 the Japanese Army was negotiating for the following types of tubes, but there is no evidence that the contracts were ever concluded:

a. Braun (cathode ray) tubes for use in the Würzburg.

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b. Special type vacuum tubes, such as klystron induction power tubes.

c. Latest short-wave decimeter tubes and complete instructions for use.

d. Tubes for receiving decimeter waves.

As regards Japanese Navy purchases in Germany, little information is available on types of vacuum tubes acquired. In October 43, negotiations were being carried on by the Japanese Naval representatives in Berlin for a large number of LG-10 type vacuum tubes, which were said to be a substitute for selenium rectifiers; it is not known whether any samples reached Japan. In November 43, the Japanese Navy received permission from the German military authorities to purchase five LG-1 and five LG-2 receiver tubes from Telefunken. Those tubes were scheduled for delivery and shipment in December 43, and although there is no evidence of shipment, may have reached Japan early in 1944.

Negotiations for manufacturing rights: In addition to purchasing samples of vacuum tubes, the Japanese Army and Navy also carried on negotiations to obtain manufacturing rights for various types of German tubes. Negotiations to obtain the manufacturing rights for

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Telefunken vacuum tubes were begun by the Japanese Army in February 42. The following types were desired at that time:

Those used with 92 decimeter waves
LD-15
LS-180
LS-50
LG-1
LD-2
LD-1
LB-2
LG-2
LD-5
LV-1
LB-1
EF-14

In the spring of 1944, Japanese Army and Naval authorities in Tokyo requested manufacturing plans for seven types of Telefunken tubes. It is not known whether the original list of thirteen tubes was cut down to seven or whether the second list covers only high priority items:

LS-180
LS-50
LG-2
LD-2
LV-1
LD-5
LB-1 Braun tubes

The Japanese intended to use these tubes in Würzburg equipment. At the same time Japan also requested the following data and materials in connection with the manufacturing

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drawings for the above tubes:

a. Tools used in assembly.

b. Welding process and welding material used for assembling the electrodes as well as manufacturing machinery.

c. Metals for plating the surface of the anode and technique for the process.

d. The production process and information on materials in connection with manufacturing the cathode.

e. Stem manufacturing machinery.

f. Composition of the metals which are fused into the stem glass.

It is thought that drawings for LS-180, LS-50, LG-2, LD-2, and LV-1 tubes--and possibly for LD-5 and LB-1 tubes--reached Japan during 1944. A contract for manufacturing rights for the tubes listed above was never concluded by the Japanese Army and Navy with Telefunken, because of failure to agree as to whom the rights should be transferred. For some time contracts had existed between Telefunken and Nippon Musen Denshin K.K. (Japanese Wireless and Telegraph Company) and between Telefunken and Mitsubishi Denki K.K. (Mitsubishi Electric Company),

under the terms of which Telefunken had assigned those Japanese firms the right to manufacture and sell Telefunken products in the Far East.* It was reported in June 44 that, if those contracts were renewed, Telefunken also would agree to transfer to those companies rights to manufacture all Telefunken vacuum tubes. In March 45, it had still not been decided whether manufacturing rights were to be transferred to the above two firms, other Japanese firms, or to the Japanese Army and Navy. Germany then proposed that each type of vacuum tube should be made the subject of a separate contract. It is not thought that these points of contention had been resolved by the time Germany surrendered.

Negotiations with the Gema Company were more successful. In July 44 the Japanese Navy acquired from Gema manufacturing rights for the following search receiver tubes:

TS-6
SD-6
VH-3

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*Three of the five types of tubes Nippon Musen is known to have produced were copies of Telefunken types. One LS-66 tube which was recovered in the Far East bears the Nippon Musen trademark and the legend "made in Germany".

The Japanese Navy in May 44 requested information from Germany regarding methods of manufacturing magnetrons and requested samples of the finished products, machinery, drawings and technicians. By 15 February 45, it had been decided, in order for the Japanese to investigate the details of magnetrons, they would have to purchase the manufacturing rights of two types: LMS 100 (transmitter use) and RD-2 Ma (receiver use). It is not believed that the contract was concluded or that this material was ever shipped to Japan.

<u>Technical data and technicians</u>: In addition to the acquisition of prototypes and manufacturing rights for vacuum tubes, the Japanese Army and Navy also requested and received from the Germans a considerable amount of technical information regarding the following:

LS-180 vacuum tubes
Raytheon 723A (an American tube)
LD-20 tubes
LB-9-N cathode ray tube
LB-2 cathode ray tube
Methods of manufacturing tungsten filaments

The following German radar technicians have been sent to Japan and have given the Japanese technical aid in manufacturing vacuum tubes:

Heinrich Foders, Telefunken engineer--arrived Far East August/September 43.

Brinker, Gema Company engineer--arrived Far East July/August 43.

The following Japanese radar technicians received training in Germany and returned to the Far East:

Matsui--arrived July 44

Satake--arrived August/September 43.

One Janapese vacuum tube technician, scheduled to arrive in Germany in the summer of 1944 to study micro-wave vacuum tubes, was said to have been lost en route.

The Japanese Army negotiated throughout 1944 to obtain from Germany more technicians skilled in the latest techniques. The results were not successful.

<u>Insulation materials</u>:

An important factor in Japanese backwardness in radar development was her failure to keep pace with the improved insulation needed for high frequency cables. In fact, a German radar technician, who, at the time of Germany's surrender, was en route to Japan to assist the Japanese in their radar and infra-red program, stated that the Japanese possessed no high grade insulating material for use in radar construction.

<u>Ceramic insulators</u>: As early as 1942 the Japanese began negotiations for the manufacturing rights

for Hescho ceramic insulation material. In June 44, the Japanese Navy was pressing for the conclusion of a contract for the same firm's high frequency condenser, for which some plans apparently already had been received. It is not believed that the contract with Hescho was ever concluded and it is thought that the Japanese never acquired complete data on ceramic insulation material. Over 400 high frequency condensers were found in the cargo of the U-234.

In January 45, a Japanese technician from Fuji Electric Company was receiving practical training at the Hescho factory on porcelain insulation for high frequency work and was thought to have made good progress in acquiring the practical technique needed in Japan. A plan by which the Navy hoped, in the autumn of 1944, to send several Japanese to Germany for that purpose was abandoned because of the difficulty of getting them to Europe.

<u>Plastic insulators</u>: Japanese interest in the development of plastic insulators was of much more recent date than was the case with ceramic types. It was in the autumn of 1944 that the Army began inquiries in Germany on the methods used by both Germany and Great Britain to polymerize certain hydro-carbon compounds into their

heavier end products polyethylene, polyisobutylene and polystyrol. The ultimate use of those plastics was for ultra-ultra short wave insulation for radar.

In February 45, the Japanese hoped to avoid having to buy manufacturing rights for plastic insulation materials by obtaining the information from I.G.Farben under the Hydrogenation contract; it is not believed that they ever acquired very detailed information or blueprints for the process.

Radar test equipment:

In September 44 the Japanese Army requested models and drawings of a number of unidentified items of ultra-high frequency measuring equipment; it is thought that none of the items was shipped to Japan.

According to Foders' October 44 report on Japan's electronics position, the Japanese were in a difficult position with regard to radar test equipment.

SECTION IV

LAND ARMAMENTS AND AMMUNITION

Note: Brief descriptions of the equipment discussed in Section IV are contained in TAB J.

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LAND ARMAMENTS AND AMMUNITION

Small arms:

7.92 mm MG-34: Early in 1943 the Japanese Army attempted to secure manufacturing rights for this weapon from Rheinmetall-Borsig, but the German High Command opposed the transfer. There is no evidence that prototypes were shipped to Japan.

7.92 mm MG-42: The Japanese Army was anxious to secure the manufacturing rights for this weapon early in 1943 and the German Army was willing to grant permission; there is no evidence, however, that a contract was ever signed. In June 43, Army representatives in Berlin procured a general outline of German methods of manufacturing the MG-42 and it would seem that at that time manufacture of the gun in Japan was contemplated.

7.9 mm M.P. 43: Drawings for the 43 pistol and ammunition were shipped from Europe in mid-1943 and may have reached Japan.

7.9 mm M.P. 44: In September 44 Japanese Army representatives in Berlin proposed purchase of the manufacturing rights for this pistol. Drawings on film were said to have been sent to Japan in 1943. Apparently,

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because of the complexity of the equipment and the difficulty of using it on a large scale, it eventually was decided that manufacturing rights should not be purchased.

9 mm M.P. 40: In March 43, the German Army offered the Japanese Army the manufacturing rights for this pistol. It is not known whether a contract for manufacturing rights was concluded but in mid-1943 drawings for the 40 type pistol and 08 type ammunition were shipped from Europe and may have reached Japan by the end of the year.

Breda pistols: The Japanese Army carried on extensive negotiations for 20,000 Breda automatic pistols, 7.65 and 9 mm, but there is no evidence of shipment or acquisition of drawings and manufacturing rights. It seems probable that pistols and sub-machine guns were involved but evidence is not definite on this point.

Accessories: Drawings of a German 1942 type machine gun mount were shipped to Japan in mid-1943.

In November 41, the Japanese received considerable detail on the Mauser Company method of manufacturing rifle stocks from laminated materials.

Anti-aircraft weapons:

88 mm Flak: Models of the 36 type 88 mm AA gun were purchased by the Japanese Army in Germany in 1942 and probably shipped to Japan. One 37 type, together with ammunition, was shipped from Europe by the end of 1943 and is also thought to have reached the Empire. By July 43, one 38 type AA gun also had been purchased and possibly shipped, while negotiations were in progress for the type 41. The last mentioned model probably was acquired too late for shipment by surface blockade runner.

The Japanese contract with Krupp for the 37 type AA gun specifically excluded rights of reproduction in Japan, although Krupp did state that the necessary arrangements to this end could be made if Japan so desired. Purchase of the gun included data transmission apparatus (on carriage equipment) for height, azimuth, and semi-automatic fuse setter auxiliary equipment, plus specimens of HE ammunition with 30-second time fuse and armor piercing HE ammunition with base fuses.

It should be noted that the Japanese Army type 99 80 mm dual purpose gun is reported by P/W's to be based directly on the German 36 and 37 type 88 mm Flak and the Japanese version is believed to be a close copy

of the German models.

One 88 mm Flak 37 and ammunition destined for Japan was reallocated to the GAF in 1943 when transportation space was no longer available for shipment to Japan.

<u>105 mm Flak</u>: In March 43, rights to manufacture the 40/2 type 105 mm anti-aircraft gun were offered to the Japanese Army but there is no indication that the contract ever was concluded. By that date, however, one 38 type 105 mm anti-aircraft gun, together with ammunition, had been purchased and shipped, and a contract for the 39 model had been signed. It is known that a 39 model and 43 boxes of ammunition purchased by Japan later were turned back to the GAF when shipment to the Far East could not be arranged.

<u>Quick loading apparatus for 10 cm AA gun</u>: In January 45, the Navy was negotiating for drawings for a quick loading apparatus for a 10 cm Rheinmetall-Borsig AA gun to be sent to Japan by submarine. It is not believed that a contract was concluded before the end of the European war.

<u>Anti-aircraft fire control equipemnt</u>: The

Japanese appear to have been given every opportunity to study German anti-aircraft strategy and tactics and Japanese personnel in Germany made a full study of German defenses. A microfilm on German AA defense systems, scheduled to be sent to Japan in April 45, was never loaded for shipment.

Japanese AA defenses and tactics in both the Navy and Army were believed to be far behind those of Germany. While the Japanese undoubtedly were producing efficient AA weapons, they were deficient in the production and employment of warning D/F and AA predictor devices.

Japan planned to send technicians to Germany to study AA techniques. There is no evidence that such individuals arrived in Europe. Arrangements were made in 1944 to have two German AA experts--Sandrart and Schumann--go to Japan with the general object of improving Japanese AA defenses. Sandrart was captured on board the U-234; Schumann was captured in Europe after the collapse.

During interrogation of General Kessler it was revealed that the Japanese in 1942 acquired a sample of the German Kommandogerät 40 and shipped that director apparatus by submarine. The Japanese then claimed that

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this apparatus was lost in transit and requested that a replacement should be provided. The Germans were said to have acceded to this request though they were doubtful that the Japanese report was correct. General Kessler asserted that the Japanese have reproduced the Kommandogerät 40.

Miscellaneous: In addition to the foregoing, Japanese representatives in Germany, in May 44, received descriptive data on the following:

20 mm Mountain Flak 38
50 mm Flak 41
128 mm Flak 40
128 mm Flak 40 (twin)
Flak sight 38
200 cm 40 A Flak searchlight

Guns, howitzers and rocket weapons:

20 mm Antitank gun: In March 43, the Germans agreed to transfer to Japan manufacturing rights for the 28 mm antitank gun. The outcome of that offer is not known.

73 mm Rocket gun: In March 43, manufacturing rights for this rocket gun were offered to the Japanese; there is no evidence as to Japanese reaction to that offer.

75 mm Recoilless gun (75 mm LG-40): Drawings for this gun and for 38 type hollow charge and armor

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piercing ammunition were shipped from Europe in mid-1943.

75 mm Antitank gun 40: In March 43, Germany, if the Japanese so desired, was willing to transfer the manufacturing rights for this weapon to Japan. There is no information as to whether the rights ever were acquired, but in mid-1943 drawings of a 75 mm antitank gun, type unspecified, and 1939 and 1940 type armor-piercing ammunition were shipped from Europe.

75 mm Antitank gun 41: In July 43 it was reported that the Japanese Army was about to begin manufacture of the 75 mm antitank gun 41 and the Military Attaché wished to reach an agreement with the Germans on patent rights. A model of this gun and its breech block--together with samples of 1938 and 1939 type hollow charge ammunition--and manufacturing plans had been presented by the German Army to the Japanese Army in January 43. This material may well have arrived in Japan by the middle of 1943.

Antitank rifle 41: (This weapon cannot be clearly indentified but it is believed to be the SPZ B41 taper bore 28/20 Gerlich weapon.)

Drawings for a heavy 1941 type antitank rifle, parts and 1941 type armor-piercing and explosive

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ammunition were dispatched to Japan, where they may have arrived about December 43.

150 mm Howitzer (?SFH 18): Manufacturing rights for the 150 mm howitzer were offered to the Japanese in March 43; there is no indication that a contract was signed. The Japanese may have purchased a Krupp model in 1942.

210 mm Krupp SK-38: One model with ammunition was shipped from Germany by March 43. In February 43, negotiations were in progress in Berlin for manufacturing rights for a Skoda 210 mm gun, which may have been the Krupp model of the Skoda type. There is no evidence that rights were acquired by Japan.

240 mm Howitzer (type not determined, possibly Skoda): The German Army offered the Japanese the rights to copy this weapon in February 42. One model and ammunition are thought to have been purchased and shipped to Japan at that time.

380 mm Turret gun: In June 44, the Japanese Navy was negotiating with Krupp in respect of a Krupp 380 mm turret gun. At that time plans already had been supplied to the Navy, but no contract had eventuated because of a disagreement over price. Captured

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documents imply that a license agreement for this weapon may have been contracted toward the end of July 44.

Panzerschreck and Panzerfaust--antitank weapons: The Japanese Army and Navy both have shown considerable interest in these weapons and the manufacturing rights for the Panzerfaust were presented to the Japanese Army in November 44 as a gift from Hitler outside the Manufacturing Rights Agreement; manufacturing rights for both weapons were acquired by the Navy from Hugo Schneider by December 44. Navy representatives in Germany, by November 44, also acquired one hundred Panzerfaust and two Panzerschreck with manufacturing drawings. It is believed that none of this material reached Japan. Twenty-four Panzerfaust and one Panzerschreck were found in the cargo of the U-234 when that submarine surrendered.

Panzerblitz: In March 45, data on the Panzerblitz was obtained by Naval representatives in Berlin. There is no further evidence as to Japanese acquisition of prototypes or plans of this rocket weapon.

150 mm Nebelwerfer 41: As early as March 43 the German Army was willing to transfer manufacturing

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rights for their 41 type 150 mm rocket gun to the Japanese Army, but it is not known whether a contract ever was signed. Drawings for the 41 type 150 mm rocket gun and ammunition are known to have been shipped from Europe in the summer of 1943. In February 45, the Japanese Military Attachè in Berlin obtained more details on the 150 mm Nebelwerfer 41 and its ammunition; this material was to be sent by the next submarine to leave Europe. There is no indication of shipment.

<u>Other models of rocket launchers</u>: It is reported that in February 45, the Japanese Military Attachè in Berlin was preparing a detailed report on German rocket guns and their ammunition for transmission to Japan by submarine. The weapons in question are believed to be the following:

(i) 210 mm, 280 mm, and 300 mm Nebelwerfer;

(ii) Portable rocket launching rack - 1940 and 1941;

(iii) Rocket launcher mounted on a truck - 1940;

(iv) 150 mm rocket launcher mounted on an armored car - 1942; and

(v) Rocket launcher for projectile containing propaganda leaflets - 1941.

<u>Long-range rocket projectile A-4, (V-2)</u>: There is no evidence of official release to the Japanese of

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information concerning the A-4 long-range rocket. In fact, the only evidence on the subject indicates that Hitler refused to divulge details to the Japanese; any knowledge they may have acquired on the weapon can only be of a most general hearsay nature.

Ammunition and explosives:

12.7 mm ammunition: A technical report on, and plans for, the methods of producing 12.7 mm ammunition used by Deutsche Waffen Maschinen Fabrik, sent to Japan in 1943, reportedly were lost en route. Another set of the report and plans is believed to have been shipped in 1944, and may have reached Tokyo.

Two million rounds of Breda ammunition were purchased from Italy and shipped to Japan in 1943.

Fuses: a. Rheinmetall electric fuse: The Japanese Army first became interested in this fuse in June 41, at which time the purchase of manufacturing rights was considered; subsequently it was decided instead to purchase sample fuses. About July 43, however, manufacturing drawings for the Rheinmetall electric fuses had been dispatched and lost en route to Japan, implying that rights had been acquired before that date. There is no evidence that duplicate documents

were shipped to, or reached, Japan.

b. Tavaro Company time fuse: In March 42, Japanese Naval representatives in Berlin acquired information on the time fuse manufactured by the Swiss Tavaro Company. Major Kobayashi was said to have investigated this fuse and its manufacture in 1941 and found that, in addition to its use on anti-aircraft guns, it was adaptable for bomb use. In March 42 Naval representatives in Berlin were planning to send a catalogue describing the fuse to Tokyo by the next surface blockade runner. There is no subsequent information concerning this transaction nor of the shipment of drawings or samples.

c. Thiel time fuse: In May 1942, the Japanese Navy requested detailed information regarding the Thiel time fuse. Particulars of machinery, testing and mass production were requested; manufacture in Japan apparently was contemplated. On 7 May 43, the GAF presented free of charge to the Japanese Navy manufacturing rights for the Thiel S/30 time fuse and ordered that data required for manufacture immediately be turned over to the Japanese Government. There is no information indicating whether or not manufacturing

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drawings reached Japan.

d. Proximity fuses: It is not believed that the Japanese Army or Navy requested, or received, any information from Germany on proximity fuses. However, Dr. Otto Scherzer, of the University of Munich and Scientific Chief of the Central High Frequency Research Station in Germany, stated that copies of all reports which he held had been transmitted to the Japanese. These reports were said to have included detailed information on "Fox" and all other types of German proximity fuses. On the other hand, Professor Wagner of Henschel stated that the Japanese had no information about proximity fuses. General Kessler, when interrogated, stated that samples of proximity fuses were on the U-234; examination of the cargo proves that this was not true. It is unlikely that Japan had any information, other than of a very general nature, on German proximity fuses.

Grenade and mortar shells, 38 and 39 types: Drawings and samples of 38 and 39 type grenade and mortar shells were shipped from Europe early in 1943 and probably reached Japan by the end of the year.

Steel shell and cartridge cases: In 1942 the

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Japanese Army acquired the Polte Armature and Machine Company's process for manufacturing steel shell and cartridge cases. This process, as offered, apparently covered 7.9 mm ball, 37 mm antitank and 88 mm high-angle field gun ammunition, but, upon Japan's request, German 50 mm antitank gun ammunition was substituted for the 37 mm ammunition. It is believed that Japanese technicians were trained in the process at the Polte Company, but it is not known whether these technicians returned to Japan. The necessary blueprints for the Polte process and samples of the cases are believed to have reached Japan.

There also have been negotiations for several processes for special steels to be used in manufacturing cartridge cases--such as the Krupp Company Open Hearth process and the Ferrital process (see Section VI). In November 43, trial manufacture of steel for Japanese cartridge cases was begun at the Krupp plant in Essen.

Brass shell cases: In addition to the process for manufacturing steel cases, the Japanese, in July 43, proposed purchase of complete equipment for the manufacture of 12.7 mm and 20 mm brass cases. It is not known how

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far negotiations progressed.

Steel core bullets: In August 43, the Japanese were considering the purchase of the I.G. Farben process for manufacturing steel alloy for steel core bullets. It is not known whether details of the process or rights were acquired.

Hexogen or RDX explosive: In the autumn of 1943, the Japanese wereanxious to obtain details of the method of manufacturing hexogen, used as an explosive in bombs and ammunition. A detailed report is believed to have been sent to Japan at that time and a Japanese technician inspected a German factory making this product.

Diethylene glycol dinitrate: This material is used as an explosive and a propellant. Information describing the technique of manufacture is believed to have been forwarded to Tokyo.

Liquid air: In June 44, the Japanese Navy was extremely anxious to obtain the German technique for producing a special liquid air explosive used in rocket shells. No further details are available.

Nitroglycerine: Japanese Army officials in Berlin examined in September 44 the Meissner process for manufacturing nitroglycerine and apparently were

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proposing that Japan import technicians from Germany and purchase the process. It appears that Japan had no interest in the process as no further action appears to have been taken.

Poison gas: The Japanese Army made several requests for information on German poison gas techniques, but no information was supplied. In October 44, there was a suggestion that technicians be exchanged between the two countries for study of poison gas; nothing ever came of the proposal. Two light gas masks were shipped from Europe by submarine in June 44.

Vehicles:

PzKw III: In May 41, details of this tank were obtained by Japanese Army representatives in Berlin. Subsequently Hitler authorized the sale of two models, one with a long 50 mm and the other with a short 75 mm gun. These were shipped from Europe by March 43 and may have reached Japan. Manufacturing rights are believed to have been acquired by the Japanese Army, but, as of May 44, there was evidence that the Japanese were not planning to proceed with manufacture.

PzKw IV: Two specimens of PzKw IV/F2 tank,

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mounting a 40 type 75 mm antitank gun, were purchased and shipped to Japan by March 43. Manufacturing rights are thought to have been procured, but as of May 44, the Japanese apparently had decided not to put this tank into production.

PzKw V (Panther): A model of the Panther tank was purchased in September 43--too late for shipment to Japan. Japanese officers attached to the German Army received instruction in its employment. There is evidence that the Panther tank (or a close copy) was being made in Japan, although there is no indication of Japanese purchase of appropriate manufacturing rights or drawings.

PzKw VI (Tiger): A model of the Tiger tank also was purchased in September 43. Interrogation of Kurt Arnholdt, chief tank test engineer for Henschel & Sohn, revealed that, about September 43, four Japanese officers visited Arnholdt at a tank testing and proving ground. They were especially interested in Tiger tanks which had been modified to permit fording streams up to five meters in depth. Arnholdt believed that the German High Command already had furnished the Japanese with microfilms of the Tiger I and II tanks, and possibly

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with blueprints.

Armored cars: In February 42, one Böhmisch-Märische Maschinen Fabrik armored combat car was offered to the Japanese, with rights to copy if required. There is no indication that models or drawings ever reached Japan.

Arthur Tix, President of Henomag AG, Hanover, stated that in 1943 his company had been instructed to send full drawings of their 3-ton half track armored car to Japan via the Japanese Embassy. It is not known whether those drawings actually reached Japan.

A captured letter from the files of Demag A.G. states that, on 13 April 43, the Japanese Army signed a contract with Demag for the purchase of four one-ton armored troop carrying vehicles, type D 7 P (special motor vehicle 250). The contract was for a straight purchase and did not involve manufacturing rights or rights to copy, or in any way reproduce, the vehicles in Japan.

Motor vehicles: In November 43 the Henschel Company proposed the establishment of a joint German-Japanese enterprise to manufacture motor vehicles in Japan. Very little detail is available but apparently

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the plan envisaged a monthly production of 1,000 - 1,500 $4\frac{1}{2}$ ton trucks by collaboration between Henschel and some unnamed Japanese industrialist. The Japanese appear to have been interested in the proposal and inquired as to the general attitude of the German Government on this question and the possibility of joint German-Japanese production of military materiel apart from vehicles.

<u>Charcoal burning automobiles</u>: Resulting apparently from dissatisfaction with their own equipment, the Japanese requested details and drawings of German gas producers. No detail is available as to the outcome of the negotiations.

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SECTION V

OPTICAL EQUIPMENT

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OPTICAL EQUIPMENT

Optical glass:

The Japanese have had close association with Germany on optical glass for many years. Carl Zeiss has an agency in Tokyo, and apart from large imports by this firm, the Japanese also have bought from other German firms, notably Schott and Leitz.

In the days of surface blockade running, extensive purchases were made through ordinary commercial channels; concurrently, the Army was buying and shipping for specific military uses during 1942-43. With the end of surface blockade running in the spring of 1943, the familiar pattern of Japanese purchasing policy on a new basis was reproduced in purchases of optical material. Through 1944 the Army and Navy took charge to an increasing degree, although Mitsubishi continued to negotiate for, and collect data on, glass manufacturing techniques. Optical glass is particularly suitable for submarine cargo and apparently retained a high priority for transport by Japanese and German submarines.

The Japanese, in the late stages of the European war, showed interest in two closely related types of

special glass--Certal and Neophane. As the Germans are believed to have provided data on the selective absorption coefficients of these materials in the visible spectrum, the Japanese apparently required these materials for some form of color filtering, possibly to produce more natural effects in aerial photography.

The Japanese produced optical glass themselves but in 1944 there was strong evidence that Japan was in short supply of such material. Continued Japanese purchases and shipments when space was at a premium bears this out, since there was no indication that glass shipments had been for prototype use. A little more light on the unsatisfactory state of home production is afforded by the inspection by Mitsubishi representatives of the Zeiss plant. That inspection revealed specially detailed Japanese interest in the manufacture of crucibles for use in making optical glass. Furthermore, the Japanese apparently did not require from Europe raw materials for optical glass production.

Towards the end of the war, the Japanese in Germany were negotiating for still closer collaboration with Zeiss. The acquisition of special processes was in question; it is not possible from avilable evidence to

specify details, nor to infer to what extent Zeiss, or other German technicians actually were to supervise production in Japan. It would appear that the Zeiss process for increasing the final penetrability of glass was to be substituted for the Leitz process previously in use by the Japanese Navy, but not considered to be as good as the Zeiss or Schott methods.

As an indication of the quantity of glass which the Japanese obtained from Germany, Zeiss-Jena shipments have been ascertained from German records in the following amounts:

October 37 to September 38	730.4 tons
October 38 to September 39	574.7 tons
October 39 to September 40	256.6 tons
October 40 to September 41	1,153.3 tons
October 41 to September 42	905.3 tons
October 42 to September 43	672.3 tons
October 43 to September 44	1,490.9 tons

The above tonnages represent sales ex-Jena; sales from other glass makers in Germany are believed to be of negligible quantity.

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SECTION VI

MANUFACTURING PROCESSES; RAW MATERIALS: SPECIAL MANUFACTURED MATERIALS

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MANUFACTURING PROCESSES: RAW MATERIALS: SPECIAL MANUFACTURED MATERIALS

Manufacturing processes:

Aircraft:

a Henschel Company mass production technique for aircraft: In October 44, the Japanese Navy became interested in the Henschel Company's method for the mass production of aircraft--used in Germany by Dornier and Heinkel as well as Henschel--and detailed reports of the process were compiled by Navy technicians.

In November, Naval representatives in Berlin began negotiations to buy the manufacturing rights for the process and to arrange to send an engineer and the necessary drawings to Japan. Later that month, films describing the production of spars for the ME-109 and ME-410 and the production of wings for the ME-109 were delivered to Japanese representatives in Germany. In January 45, manufacturing rights for the Henschel process were released to the Japanese Air Force. Drawings and films were acquired too late for shipment to Japan and negotiations for a Henschel engineer to go to Japan never were concluded. Pohl, a Henschel Company engineer already in Japan, is reported to have a general knowledge

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of the process.

b. Heinkel Company techniques: In October 42, Japanese Naval authorities were anxious to arrange for the construction of an aircraft factory in the Far East in collaboration with the Heinkel Company; Hitachi Aircraft Company was to be the opposite party in Japan. Hitachi was scheduled to build the factory, while machinery, machine tools and production technique would be contributed by Heinkel. It is not believed that the plan ever materialized.

c. Junkers techniques: In September 41, negotiations were begun between Junkers and the Manchu Aircraft Company for the conclusion of an agreement whereby Junkers would supply to the Japanese firm aircraft, machine tools, Jumo-211 engines, manufacturing techniques and technicians, and, in return, would receive a capital interest in Manchu Aircraft Company. The Japanese Government was anxious to promote the enterprise in order to procure German production skill and equipment; it is not known, however, whether the agreement ever was concluded.

Although there is no evidence of a tie-up between Manchu Aircraft and Kawasaki Aircraft, the

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Junkers Company appears to have been in negotiation for a similar joint enterprise with Kawasaki. Information on that project is incomplete, but Kawasaki planned to manufacture Junkers aircraft and engines and Junkers was to contribute manufacturing rights and the necessary technical aid and equipment. Difficulties in transportation of personnel and equipment from Europe to the Far East interfered with realization of the plan. The scheme appeared to cover a wide field of mass production techniques, prototypes, and equipment and may have included Junkers, Messerschmitt and Henschel procedures in engine and aircraft manufacture.

d. __Machine tools for the mass production of aircraft__: Negotiations were begun by the Japanese Army in July 1944 to secure plans and manufacturing rights for machine tools for aircraft manufacture. At that time Army representatives in Berlin had begun negotiations for manufacturing rights for certain machines, and was preparing to negotiate for the rights to other German machine tools. There is no further information on the outcome of these negotiations.

It has additionally been established that prior to the outbreak of the German-Russian war a large quantity

of machine tool and heavy industrial equipment was supplied by the Germans to Japan, Korea, and Manchuria, this material having been transferred by the Trans-Siberian Railway. (TAB N provides details on the materiel known to have been transferred by this means.)

g. Light alloy castings for Daimler-Benz motors (aircraft and marine): In August 44, the Japanese Army requested that a German technician skilled in the production of large, light alloy castings for Daimler Benz engines, be sent to Japan. At that time detailed explanations and photographs of the technique and equipment used in the large-scale production of cylinder blocks and crank housings also were required. In September it appeared impossible to secure German technicians because of their scarcity in Germany and the disorganization of the industry as a result of air attacks. However, two engineers from the Furukawa Company and one engineer from Sumitomo, who reached the Far East during 1944, are thought to have received technical training in this field in Germany and may have furnished valuable information to the Japanese. There is no information as to whether the drawings and photographs requested in August were sent to Japan. In

January 45, the Japanese Army was apparently anxious that negotiations for the manufacturing rights for light alloy castings be stepped up, but it is not thought that the rights were acquired.

f. Giessharz: In April 45, Japanese Naval representatives in Berlin obtained information on the production of Giessharz, a castable resin suitable for making moulds used in processing light alloys for aircraft fuselages. On 11 April 45 manufacturing rights for Giessharz were released to the Japanese.

g. Ruhrstahl steel casting method: In June 41, the Japanese Army and Navy both initiated negotiations for the Ruhrstahl steel casting method. The Army planned to have the Kobe Steel Works conclude an agreement with Ruhrstahl, while the Navy was to have Hitachi Manufacturing Company negotiate with Ruhrstahl. Evidence points to the discontinuance of these negotiations.

h. Wooden aircraft: The Japanese Army and Navy have evidenced considerable interest in German methods of manufacturing wooden aircraft and their Attachès in Berlin have investigated or purchased the following processes:

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(i) In late 1942, an artificial wood pressing process developed by Dynamit A.G. was released to Japan.

(ii) In September 44, the Japanese Naval representatives in Berlin visited one of the Messerschmitt plants and studied the manufacture and use of Tego film, an adhesive used in the manufacture of wooden aircraft. Construction of the wooden parts of the ME-163 B also was studied.

(iii) In February 45, the Japanese Army indicated their wish to purchase manufacturing rights for Kaulitfilme--a urea resin composition sheet used as a bonding material for plywood and laminated material of wooden aircraft--in order to acquire the necessary detail on the material and its applications. The contract was not concluded.

(iv) A contract was conluded in February 45 between the Japanese Navy and Schwabische Formholz, Ulm, for the transfer of patent rights for the Belis process for construction of aircraft from plywood. This process was developed jointly by the firm Erwin Behr, Wendlington, and Messerschmitt, and served the strengthening of wood by mould-

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ing of veneer strips glued with Tego film. Japanese employment of the rights was to be for the duration of the war only.

As one of the terms of the contract, the following documents were delivered to Japanese representatives in Germany in December 44:

a. Ten production machine drawings and drawings of machine parts.

b. Two manuals on production machines.

c. Two delivery regulations.

d. Two lists of essential machinery and equipment required for production.

An arrangement existed for the training of Japanese technical personnel and Schwabische Formholz apparently were willing to supply German specialists to install the process in Japan. A German P/W has stated that a commission of Japanese was trained in the Belis process at Wendlington.

Japanese interest in the Belis process arose as a result of their interest in manufacturing the ME-210, ME-163 and ME-262 and their inability to produce special resilient steel sheet for parts of aircraft fuselages.

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(v) In April 45, Navy representatives in Berlin acquired information on initial development work on Homogen--a fiber with binder--and Lignogen--a fiber without binder--for use in the manufacture of fuselages of wooden aircraft. Manufacturing rights for Homogen and Lignogen were released to the Japanese Navy on 20 April 45.

(vi) Japanese in Germany also have studied the British Mosquito; parts and drawings were made available to them but the shipment, of parts at least, appears to have been lost en route.

<u>Fuels</u>:

<u>a</u>. <u>I.G. Farben hydrogenation process:</u> Negotionations for the I.G. Farben hydrogenation process were begun by the Japanese Army in 1941, but it was not until January 1945 that the contract finally was signed. The long delay was due principally to Japanese reluctance to pay the price demanded by I.G. Farben and that company's unwillingness to transfer patent rights which were legally held by the International Hydrogenation Patents Company (IHP) at The Hague.

Throughout the war strenuous negotiations were also carried on by the Japanese Army for the special

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machinery necessary for the hydrogenation process, but no deliveries were made because German industry was too busy with home orders.

Under the terms of the hydrogenation agreement, I.G. Farben was to make available to the Japanese Army patent rights and technical aid regarding methods, equipment and catalysts for the hydrogenation process as far as these were necessary for the operation of hydrogenation plants in the Far East. It is thought that the agreement applied to Japan, Manchuria and China, and rights transferred by I.G. included its own and those received from third parties, including IHP.

The hydrogenation process within the meaning of the agreement is understood to include the processes by which coal, brown coal, coal tars, lignite, peat, wood waste and petroleum are used to manufacture the following products by the introduction of hydrogen or a hydrogen compound: aviation gasoline, methane and other hydrocarbon gases, light oils, heavy oils, lubricants and paraffin (wax?).

On 15 January 45, a laboratory was set up by I.G. Farben at Heidelberg to construct and experiment

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with an apparatus designed to produce aviation gasoline from various types of Manchurian coal. The experiments were delayed by last-minute changes in Japanese ideas concerning raw materials, and it is believed that little was accomplished by the end of the European war.

Arrangements were made by Mitsubishi to purchase blueprints and manufacturing rights for various types of manufacturing equipment from German firms, but the rapid development in the military situation prevented the Japanese from receiving those plans and drawings. Several Japanese technicians--Fukao, Kinoshita, Mikami--were trained at I.G. Farben plants before the Allied troops entered Leverkusen, but none of those technicians returned to Japan, nor were any German technicians sent to the Far East. Lt. Col. Yoshida, who arrived in Singapore in July 44, is believed to have had some knowledge of the I.G. process and to have had drawings in his possession, but, inasmuch as he left Europe before the agreement was signed, it is not believed that I.G. Farben had released detailed drawings at that time. I.G. has for many years maintained an office in Japan, and the Japanese may have obtained from this source a small amount of assistance in improving hydrogenation plants already

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existing in the Far East.

b. Lubricating oils: Various processes of manufacturing lubricating oil--the Ruhrchemie and Voltol methods in particular--were examined by Japanese representatives in Germany. The Voltol process consists of the electrical polymerization of fatty oils, commonly rape seed.

In connection with the Ruhrchemie process consideration was given to methods of catalytic cracking for the production of gasoline and details were obtained of an iron catalyzer oven. A Japanese fuel expert now in Japan, Lt. Col. Hanaoka is thought to have received training at the Ruhrchemie plant.

A contract is known to have been signed in 1940 between Ruhrchemie and Mitsui in respect to production of 12,000 tons of lubricants per annum at Hokkaido Jinzo Sekiyu, and plans for the necessary plant were provided. The process was to employ soft cracking of soft wax and low temperature polymerization of Fischer feed stock comprised of either 200/320° Diesel cut or soft wax. The plant is thought to have been operating in 1942.

c. Solid petroleum fuels: In July 43,

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Japanese Army representatives in France thoroughly investigated a French process for solidifying petroleum. Negotiations for the process continued until September 44, but a contract had not been concluded at the time of the liberation of France. The Germans are thought to have acquired the French process, in which case this approach may have been open to the Japanese even after the fall of France.

The process can be applied to gasoline, heavy oils, light oils, kerosene, chloroform and paraffin and its advantage lies in ease of packing and storage. The product can be transported in wooden cases and only needs pressing to extract the original oil.

d. Alcohols: Between May and July 42, the Japanese made various inquiries in Germany as to German practice in the production of alcohol, particularly Butanol, Iso-Propanol and the conversion of Iso-Butanol to Iso-Octane. Further inquiry covered the synthesis of carbon monoxide and hydrogen for production of Iso-Butanol. Orders were placed in Germany for equipment required in the manufacture of Butanol and Iso-Butanol for conversion to Iso-Octane.

Subsequently, the Japanese appear to have lost interest in German practice, probably since Japan's

independent development in the production of alcohol from molasses, etc., was successful.

Lurgi low temperature carbonization furnace:

In 1942, Lurgi transferred to the Japanese patent rights and three sets of drawings for their low temperature carbonization furnace; those drawings undoubtedly reached Tokyo.

Iron and steel:

a. Sinter iron: The Japanese have examined in detail the process of using sinter iron as material for the rotating bands of shells and its other uses, such as for self-lubricating shaft and axial bearings. The advantage in the use of steel so manufactured lies in the economy in use of copper, or other material in short supply, which sinter iron can replace. It appears that the Japanese eventually decided not to proceed with negotiations to purchase manufacturing rights; it seems possible, however--and in fact there is some evidence to support the suggestion--that in connection with their investigation of sinter iron the Japanese also acquired information on iron powder for high frequency purposes.

b. Krupp open hearth method for steel cartridge cases: Detailed information was given to the Japanese in

December 43 on the equipment used in the process and the composition of the pig iron and of the different grades of finished steels needed for various types of ammunition. The contract for manufacturing rights had not been concluded by June 44, although by that date Japanese representatives in Germany had received manufacturing drawings. Although there is no indication that such drawings ever were shipped, it is possible that they reached Tokyo before the cessation of hostilities.

c. Ferrital process from Italy: In 1942-43 the Japanese Army was considering the purchase of rights to manufacture an Italian alloy steel known as Ferrital. This steel was designed as a substitute for copper, brass, etc., for use in small arms ammunition and cartridge cases. It is not known whether a contract for the manufacturing rights ever was concluded, but samples of the material are thought to have reached Japan. The extent of Japan's knowledge of the process is difficult to determine, but from the fact that they negotiated for small lots from Italy in 1943-44 it might be assumed that they were reasonably confident of their ability to produce that alloy.

d. Steel tube rolling mills: Beginning late in 1942 the Japanese negotiated, through Mitsui, for the

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purchase of Stiefel and Pilger steel tube manufacturing plants for Sumitomo. In late 1944 the orders were cancelled because of the transportation situation and the destruction of manufacturing plants of M.F. Meer A.G. In February of this year, however, Japanese Naval representatives in Berlin were proposing that manufacturing rights and drawings for the Pilger Mill be acquired. It is not known whether a contract was signed.

e. Coke ovens: In late 1944 the Japanese were negotiating for technical help from Germany in the construction of simplified coke ovens. The Japanese attempted to apply the same principles of simplification to Otto coke ovens in Anshan as were used in ovens of Herdt construction in Germany. This is believed to have been prompted by the high susceptibility of coke ovens to bomb damage and the relatively long time and high degree of skill required to build or rebuild those of usual construction.

Aluminum:

a. Seailles process: Negotiations were under way in May 43 for the granting of patent rights to Japanese interests for the Seailles process of alumina manufacture which was being used in Germany. The

[redacted]

process permits the manufacture of alumina from colliery wastes and limestone, and can be employed in cement works. It requires, however, a complicated and large plant and yields a small scale output. It is understandable that Japan wanted to use her surplus cement capacity and ensure any source of supply of aluminum not dependent upon imports of bauxite from the Southern Regions and Mandated Islands. There is no information as to whether Japan acquired rights to the process from Germany.

<u>b</u>. <u>Caproni Company process</u>: In September 44, Japanese Naval representatives in Italy investigated the Caproni process for manufacturing aluminum from volcanic ash. It is not known whether designs, plans and drawings were acquired.

<u>Miscellaneous</u>:

<u>a</u>. <u>Magnesium</u>: In June and July 43, Japanese Army representatives in Berlin investigated the methods then being used in producing magnesium in Germany. They were in favor of purchasing the I.G. Farben process but there is no evidence of further negotiations.

<u>b</u>. <u>Rubber</u>: Following negotiations with Mitsui in October 42, the Germans agreed to make available the I.G. Farben process for the manufacture of synthetic

rubber (Buna). The Japanese Army proposed civilian manufacture by Mitsui or its affiliates and the plan called for a plant of 9,400 metric tons per annum capacity. Drawings, technical cooperation and machinery were to be provided by I.G. Farben. It is believed that negotiations were not completed.

c. Carbide: The Japanese Army is believed to have acquired patent rights for an "airtight vacuum system" carbide manufacturing plant from Germany in 1942, but plans are not thought to have reached Japan.

d. Carbon electrodes: In November 43, Tokai Denkyoku Seizo K.K., Tokyo, concluded an agreement with a German firm for a license to operate roasting furnaces for manufacturing carbon electrodes in Japan and Manchuria. Some drawings for these furnaces already had been received in Japan by the previous September and plans were made for an engineer from the German firm to instruct the Japanese in furnace construction and operation. The remainder of the drawings were scheduled for delivery in March 44.

e. Cloth: There is some evidence that Japanese technicians were trained in Germany in cloth manufacture in 1942; five technicians with a

knowledge of German technique are believed to have reached Japan.

In February 45, the Japanese Navy was considering the purchase from I.G. Farben of manufacturing rights for a special material for the garments of personnel working on the ME-163. Since T-Stoff--concentrated hydrogen peroxide--damaged regular types of clothing, I.G. developed a product known as PG, a cloth coated with rubber material and other chemicals. In order to learn the details of this material from I.G., Japan was required to purchase the manufacturing rights. It is not known whether or not an agreement was concluded.

f. Raschig process: The Japanese Government in June 43 initiated inquiry through Mitsui with a view to obtaining rights to the Raschig process for catalytic conversion of benzene to phenol. The Germans apparently were willing to supply drawings and equipment for the experimental plant.

It may be assumed that the Japanese were interested in the Raschig process as a source of picric acid (tri-nitro-phenol for manufacture of high explosives) from coal as a raw material.

The latest information on the negotiations--as

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of January 44--indicated that they were not progressing favorably and were unlikely to be successful.

Raw material and special manufactured materials:

Considerable quantities of raw and manufactured materials were purchased by the Japanese in Europe prior to the outbreak of hostilities between Germany and the Soviet Union and were transported to the Far East via the Trans-Siberian Railway.* Thereafter, the Japanese were forced to rely upon surface vessels for the transport of goods between Europe and the Far East and a wide variety of commodities was imported by this means. Finally, in 1944-45, when trade was confined to submarine blockade running, certain raw and manufactured materials continued to move from Europe to the Far East. Their high priority makes this class of goods worth mentioning briefly.

a. Mercury: Approximately 1,500 tons of mercury were purchased by the Japanese in Italy from 1942 to the time of the Italian collapse, and this commodity held the highest priority for shipment to Japan by submarine. Information on shipments during

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*A list of those commodities appears as TAB N.

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the period of surface blockade running is fragmentary, but successful shipments are believed to have amounted to 141 tons; sinkings may have totalled 119 tons. Approximately 620 tons of mercury are thought to have been shipped in numerous submarines from Europe since the summer of 1943 with a known loss of over half of that amount.

b. Special steel: In the latter part of 1942 the Japanese placed an order in Germany for 10,000 tons of alloy steel to be produced over a period of ten to twelve months and to be used in the manufacture of aircraft engines.

A considerable quantity of the original 10,000 ton order remained to be shipped after surface blockade-running had ended. A few tons of special steel in bars were carried in the keels of the submarines which ran the blockade in 1943-44. Total arrivals are not known, but are believed to be small, inasmuch as several shipments were sunk en route to Japan, lost at Bordeaux or damaged by bombing, and large quantities are thought to have been lent back to the Germans.

c. Aluminum: In the summer of 1943, before the final abandonment of surface blockade-running, a

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very high shipping priority was given to 6,000 tons of aluminum for the Japanese Army and Navy in equal shares. The reason for this urgency has never been explained, but failing other evidence it is assumed that a special grade of purity was desired.

Some aluminum was shipped from Europe on Italian submarines in the summer of 1943 and small quantities of aluminum in bars occupied valuable cargo space of German operational submarines leaving Europe for the Far East since the summer of 1944.

d. Lead: Early in 1943 the Japanese completed a secret purchase in Spain of 1,000 tons of lead, which had all been transported to Germany by November 43. In June 44, arrangements were made to ship approximately 350 tons of this lead to Japan by German submarine and it is believed that shipments reached that figure. Of the amount shipped, at least half was probably sunk en route.

e. Platinum: The purchase of platinum in Europe was controlled from Berlin by the Japanese Army authorities but the material itself was almost entirely obtained in Portugal. The exact amounts obtained are not known. Shipments by submarine are thought to have amounted

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to at least 26 grams, of which about half probably was lost; since platinum is easy to smuggle, the traffic was never fully recorded. The associated precious metals, iridium and rhodium, also are believed to have been bought in smaller quantities.

f. Industrial diamonds: Negotiations for these were closely parallel to those for platinum. Some shipments and losses are known but, as with platinum, total acquisitions are not known. Diamond dies are believed to have retained priority for submarine shipment up to the end of the European war.

g. Industrial chemicals: Up to 1943 the Japanese bought considerable amounts of ethylene dibromide. It is thought that their own production, scaled to their output of tetra-ethyl-lead for aviation fuels, eventually was adequately developed.

Numerous chemical products were brought in Germany in former years but the substances which retained priority for more recent submarine shipment seem to have been confined to metallic zirconium, metallic lithium and neon gas.

h. Ball bearings, steel balls, and piano wire: The Japanese bought ball bearings in Germany all through

the war, but the chief source of their European supply was Sweden. The Swedish firm S.K.F. had branches in Japan proper and in Manchuria; it is thought, however, that imports on a commercial level were not large during the war. Many thousands of balls and finished bearings of different sizes were shipped by submarine and it is possible that the Trans-Siberian Railway also was used on a smaller scale for this traffic. Piano wire for use in aircraft was bought in Sweden but there is no evidence of shipments toward the end of the war.

Steel balls of diameters from 3 to 16 mm retained a priority for shipment during recent months.

i. Technical books, journals, etc.: The Japanese constantly have expended time and money in acquiring in Europe and forwarding to Japan certain books and journals of a scientific and technical nature; American and British publications figured largely therein. At one time physical and chemical text books were bought in Switzerland.

j. Special synthetic materials: The Japanese acquired information in varying degrees of detail regardinga number of synthetic products which had been developed by the Germans for special applications. In

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most cases simple descriptions of the product probably were sufficient for Japan to produce the material, while, for more complicated material, methods of production were described or demonstrated.

Examples of these special materials are:

Igetex — Synthetic rubber cloth produced from ingelit manufactured by I.G. Farben.

Vinidol — Polyvinyl chloride, an anti-corrodal material for lining ammonia tanks in production of hydrogen peroxide.

Oppanol — Lining material for retorts for production of hydrogen peroxide.

Mipram — "Curtain" used in preparation of hydrogen peroxide catalyst "D86".

Vinnol — Synthetic rubber used in preparation of hydrogen peroxide.

Klingehit — Asbestos packing used with "Z" material.

Moltopren — Low density plastic produced by Dynamit AG.

Dynal — Phenol treated wood fiber used in combination with Moltopren for trim tabs of FW-190, FW-189, TA-154 aircraft.

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TAB A

BLOCKADE RUNNERS, EUROPE TO THE FAR EAST

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BLOCKADE RUNNERS FROM EUROPE TO THE FAR EAST

SURFACE VESSELS

Successful

Vessel	Tonnage (GRT)	Departure and Arrival	Items of Interest in Cargo
a. First Season July 1941 - May 1942			
1. Portland	7,132	Oct 41 - Jan 42	Dynamos and electric power plant equipment.
2. Rio Grande	6,062	Oct 41 - Jan 42	Machinery Iron and steel.
3. Regensburg	8,068	Feb 42 - July 42	Machinery Iron and steel.
4. Tannenfels	7,840	Mar 42 - July 42	Machinery Iron and steel Tanks.
5. Dresden	5,567	Mar 42 - June 42	Machinery Iron and steel Aircraft parts.
b. Second Season Sept 42 - Apr 43			
1. Weserland	6,528	Sept 42 - Jan 43	Machinery and accessories Hydraulic tube of large dimension.
2. Brake (tanker)	9,925	Sept 42 - Dec 42	941 15 cm shells 60 rounds of 15 cm tracer 960 15 cm cartridges 8,000 3.7 cm shells 4,803 rounds 2 cm shells 13,500 rounds machine gun ammunition, fuses, etc.

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Vessel	Tonnage (GRT)	Departure and Arrival	Items of Interest in Cargo
3. Kota Nopan	7,322	Sept 42 - Dec 42	No record.
4. Uckermark (tanker)	10,000	Sept 42 - Nov 42	Ammunition, guns, aircraft, aviation oil.
5. Pietro Orseolo	6,344	Oct 42 - Nov 42	No record.
6. Burgenland	7,320	Oct 42 - Dec 42	Machinery for hydro-electric plant; aircraft parts.
7. Silva Plana	4,793	Oct 42 - Dec 42	No record.
8. Rio Grande	6,062	Oct 42 - Dec 42	Machine parts, heavy machinery, screws.
9. Osorno	6,951	Mar 43 - May 43	Aircraft, aircraft engines, zinc sheeting, mercury, weapons and ammunition.
10. Alsterufer	2,729	Mar 43 - May 43	Weapons, ammunition, aluminum, optical glass, piano wire, special steel, aircraft engines.

Unsuccessful

a. First Season July 1941 - May 1942

None

b. Second Season Sept 42 - Apr 43

1. Elsa Essberger	6,103	Nov 42 - Damaged, put back.	No record.

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Vessel	Tonnage (GRT)	Departure and Arrival	Items of Interest in Cargo
2. Spichern (tanker)	9,323	Nov 42 - Damaged, put back.	No record.
3. Anneliese Essberger	5,173	Nov 42 - Scuttled same month.	Dyes, bicycle parts, piano wire.
4. Cortellazo	5,292	Nov 42 - Scuttled same month.	600 tons hydro-turbo machinery.
5. Germania (tanker)	9,851	Nov 42 - Scuttled Dec 42	No record.
6. Portland	7,132	Feb 43 - Sunk Apr 43	Hydro-electric plant, 100 x 50 litre drums of ethylene dibromide (used for preparation of tetra ethyl lead), mercury, aircraft engines.
7. Himalaya	6,240	Mar and April 43 - Damaged, put back.	Small arms, ammunition, fuselage for German aircraft (type unknown).

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SUBMARINES

Successful

Vessel	Departure and Arrival	Cargo
a. 1942		
None recorded.		
b. 1943		
1. U-180	Feb 43 - July 43	Rendezvoused April with Japanese submarine and transferred its cargo of ammunition, drawings and weapons.
2. U-178	Mar 43 ? - Aug 43	No record.
3. U-511 (Marco Polo I)	Apr 43 - Aug 43	Technicians.
4. UIT-23 (Giuliani)	May 43 - Aug 43	Aluminum, ammunition, machinery, steel for aircraft engines, roller bearings.
5. UIT-24 (Cappellini)	May 43 - July 43	Bombsights, ammunition, ball bearings, steel for aircraft engines, aluminum, ammunition.
6. UIT-25 (Torelli)	June 43 - Aug 43	Mercury, ball bearings, steel for aircraft engines, aluminum, ammunition. Foders - Telefunken engineer. Satake - Japanese technician.
7. U-168	June 43 - Nov 43	No record.
8. I-8	Oct 43 - Dec 43	No record.
9. U-1062	Dec 43 - Apr 44	No record.

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Vessel		Departure and Arrival	Cargo
c.	1944		
1.	U-181	Mar 44 - Aug 44	No record.
2.	U-196	Mar 44 - Aug 44	No record.

Other submarines which are thought to have been in the Far East in 1943-1944 and probably made the voyage sometime during that period:

U-188
U-532
U-183
U-510
U-843
U-537
U-861
U-862
U-219

Unsuccessful

Vessel		Remarks	Cargo
a.	1942		
1.	I-30	Left Aug 42 - Sunk off Singapore Oct 42.	1 Dete Gerät 1 S-Anlage, hydrophones, weapons and drawings.
b.	1943		
1.	Tazzoli	Left May 43 - Sunk.	No record.
2.	Barbarigo	Left June 43 - Sunk.	Steel, aluminum.
3.	Cagni	Left June 43 - Surrendered Sept 43.	No record.

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Vessel	Remarks	Cargo
c. 1944		
1. U-1224 (Marco Polo II)	Left Mar 44 - Sunk in May 44.	No record.
2. U-864	Left Feb 44 - Sunk off Bergen.	Plans and parts for ME-163 and ME-262, drawings for new German aircraft. Chlingensperg - Messerschmitt technician. Schomerus - Messerschmitt engineer.
3. U-234	Left Mar 44 - Surrendered to U.S. Fleet off Newfoundland May 44.	Plans for installation to manufacture 500 ME-262's a month, data on high performance German aircraft, data on electronic equipment, uranium oxide. General Kessler and party. Bringewald and Ruf - Messerschmitt technicians. Shoji - Aircraft expert. Tomonaga - Submarine expert.

Other submarines which may possibly have been sunk en route to Japan from Europe in 1944:

UIT-22 (Attilio Bagnolini)
U-859
U-860
U-198
U-863
U-180

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TAB B

TECHNICIANS AND PERSONNEL

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TECHNICIANS AND PERSONNEL

Resulting directly from the technical exchange, various Japanese technicians were sent to Germany to study material, production and technique, and a few German technicians were sent to the Far East to train the Japanese in German methods. Over twenty Japanese technicians reached the Far East after special training in Germany, a few were lost en route to Japan, and a large number are now in Europe, having been captured by the Allies or interned in Sweden. Limited transportation facilities and sinkings of blockade running submarines and surface vessels prevented any appreciable number of German technicians from reaching Japan.

German and Japanese technicians involved in the exchange are listed in the following schedules.

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A. Japanese Personnel Now in the Far East Who Received Technical Training in Germany

Name	Function
Ashiba, Noriyuki	Representative of Japanese Ministry of Railways in Germany. Liberated by the Russians in May 45 on the surrender of Germany.
Banzai, Ichiro, Lt. Gen.	Also known as Sakanishi. Former Military Attaché in Germany. Left for Japan December 1942.
Hanaoka, Minari, Lt. Col.	Japanese Army Air Force. Investigated German lubricants. Trained in methods of manufacturing high grade lubricating oils at Ruhrchemie plant.
Iijima	Returned to the Far East with Banzai in December 1942.
Komuro, Etsuo, Col.	Commercial secretary in Germany. Liberated by the Russians on the surrender of Germany.
Nakamura, Shozo, Lt. Col.	Studied German aircraft technique. Returned to the Far East via Siberia in 1942.
Nomaguchi, Major	Studied German gun mountings.
Nomura, Naokuni, Adm.	Former member of Japanese-German-Italian Joint Specialist Commission under Tripartite Pact in Berlin. Reached Far East in summer of 1943.
Saigo	Returned to Far East in December 1942 with Banzai.
Sakato, Chikai	Medical expert. Reached Far East in summer 1944.
Sanuki	Technician from Nihon Gakki who studied wooden aircraft production in Germany. Reached Far East early in 1944.
Satake, Kiuzi, Lt. Col.	Received training in radar at Telefunken Company in Germany and returned to Far East in late summer of 1943. Believed to have worked at Tama Laboratories in Japan on the development of Japanese radar.

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Name	Function
Shiba, Hiroto, Lt. Col.	Carried on investigations of German munitions, particularly in the optical field. Trained in the production of predictor equipment for AA guns for Zeiss Company. Inspected Schott optical goods factory at Jena, and production of telescopic sight at C. S. Steinheil at Munich. Made a number of trips to Italy to conduct Japanese purchases there. Reached Far East in July 1944.
Sugita, Capt.	Medical expert. Returned to the Far East in 1943.
Suzuki, Makoto	An aircraft inspector. Was liberated by the Russians in May 1945 upon Germany's surrender.
Tanno	Aviation technician.
Tateno, Lt. Col.	Visited important oil installations in Germany in 1942. Returned to Japan before December that year.
Tsukuda, Osamu	Naval officer. Arrived Singapore 5 December 1943 after trip of 61 days by submarine. Was to be chief of Research Department, Hiratsuka Sagami Arsenal.
Ueno, Yasushi	Mitsubishi employee concerned with purchasing, shipping and insuring negotiations in various European countries. Was liberated by the Russians in May 1945 on Germany's surrender.
Yoshida, Masahiko, Lt. Col.	Fuel expert who studied German methods of production for many years. Trained in the production of solidified fuel, the I.G.Farben hydrogenation process and high grade lubricating oils at Ruhrchemie.

__Note__: Rear Admiral Yokoi, who was succeeded by Kojima as Naval Attaché, sailed for the Far East on a Japanese submarine in September 1943. Vice Admiral Nomura, who preceded Abe, left Germany in March 1943.

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B. German Personnel in Japan as of VJ-Day

I. German Personnel who Figured Prominently in Connection with Technical Exchanges

Name	Function
Brinker, Ob. Ing.	Radar technician from Gema Company. Arrived Far East in 1943 to set up plants in Japan for manufacture of radar equipment.
Foders, Heinrich	Radar technician from Telefunken Company. Arrived Far East late summer of 1943. Assisted Japanese in production of Würzburg D.
Gronau, Wolfgang von, Maj. Gen.	Air Attaché in Tokyo.
Haeberlein, Ob. Ing.	Representative of Maschinenfabrik Ausburg-Nurnberg. Reached Far East in 1943 to assist Japanese in submarine construction.
Hagemann, Hans Heinz	Junkers representative who arrived in the Far East in 1939 with three other Junkers representatives. Handled liaison between Junkers and Japanese firms.
Kaden, Herbert	Messerschmitt engineer sent to Japan in 1941.
Krayer, C., Dr.	For many years representative of Lurgi Gesellschaft fur Warmetechnik in Tokyo.
Kretschmer, Alfred, Col.	Military Attaché.
Lange, Ob. Ing.	Engineer from Deschimag sent to assist the Japanese in manufacturing U-boats and marine engines.
Nehmitz, Wilhelm, Air Commandant Engineer	Assistant Air Attaché.
Petersdorff, von, Major	Assistant Military Attaché.

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Name	Function
Pohl	Mass production engineer from Henschel Company originally charged to instruct the Japanese in the Henschel pressure process.
Ruhl, Otto	I.G.Farben representative in Japan. Scheduled to aid the Japanese in setting up I.G.Farben process for manufacture of synthetic fuels. Had been in Japan for several years.
Schmidt	Heinkel Company engineer who assisted Japanese designers at Naval Aircraft factories. Was recently reported to be building a new aircraft factory by order of Japanese Naval Air Force.
Stahmer, Heinrich, G., Dr.	Ambassador.
Steiker	Signal apparatus technician. Arrived Far East summer of 1943.
Stoer, Willi	A pilot from Messerschmitt Company who reached the Far East in 1941 where he was employed for several years.
Wennecker, Paul, Adm.	Naval Attaché.
Wohlthat, Helmut	Head of German Economic Mission to Japan. Arrived in Tokyo 26 April 1941.

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II. German Personnel Thought to be in Japan Whose Services May Have Been Enlisted for Exploitation of German Techniques

Name	Function
Abel, Wardemann	Engineer of the German Aeronautical Industry. On 28 August 1940 reported to have returned to Tokyo from a visit to Europe where he inspected GAF activities in Poland and Norway.
Baelz, Erwin Tokonosuke	Eurasian (Japanese). Arrived in October 1940 to make cultural films. Known to be still in Japan in mid-1941.
Bayer	Works with Yamamoto Shokai K.K. who import and manufacture textile and other machinery and may import Japanese military requirements (September 40).
Becker, Henry E.	Precision instruments mechanic, formerly employed by one of the Sheel Group Oil Companies. Sailed from U.S. for Japan 29 September 1940.
Bengsch, Gustav	Chief of Nazi Air Corp. Model Plane Department. Chief Instructor of German State Model Plane School. In May 41 arrived in Japan to demonstrate flying capabilities of German models. Expected to stay for seven weeks. Departure not noted.
Bergmiller, Narziss	Construction engineer to Avianca. In June 41 was en route to Japan from the U.S.
Beutner	Representative of I.G. Farben. More than 20 years in Japan.
Brecht, Walter	Believed to be Lufthansa pilot. Due to arrive in December 40 from South America.
Cording, Hans	Director of Nippon Kali Kagaku K.K. (Chemical firm - Agents for Phosphates d'Alsace).

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Name	Function
Deck, Ing.	Daimler Benz engineer attached to Air Attaché's office in Tokyo.
Ehrmann, Kurt	Representative of I.G. Farben, Tokyo.
Faste, Dietrich, Dr.	Metallurgic engineer of Krupps Grusonwerk. Arrived in Japan in November 40 from Vladivostok.
Franzen, Kurt	Civil engineer. Left U.S. for Japan in April 41.
Freeden, von	Representative of Roechling Stahlwerke, A.G.
Fricke, W.	Engineer. Left South America 8 July 1941 for Japan.
Gossler (or Kessler), Dietrich	Due to sail for Japan from South America in April 41 to be employed as electrical engineer in Manchuria.
Grutly	Is reported as ? Explosives expert (12/11/41) ? Agent (3/9/41) ? having been instructing Japanese in China in use of certain aircraft after working for a U.S. aircraft factory (27 August 1941). Reported back in Shanghai 5 November 1941.
Heckler, Karl	Believed to be Lufthansa pilot. Due to arrive in December 40 from South America.
Heinrich, Walter	Believed to be Lufthansa pilot. Due to arrive in December 40 from South America.
Herzle, Jaochim	German aviator. On 16 October 1940 reported to have arrived from South America.

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Name	Function
Hilgert, Edgar	German submarine officer. Arrived beginning of October 40 via Siberia en route to Panama. (Departure not noted).
Hinrichsen, Johannes	Trained electrical engineer specialising in wireless telegraphy. Left U.S. for Japan in April 41.
Hornemann, Rudolf	Engineer. Left South America for Japan in April 41.
Karbar, Friedrich, Dr.	Noted German metallurgist, director of Kaiser Wilhelm Iron Works. In June 41 was to be invited to Japan in the autumn.
Kaumann, G.	Chief Engineer of Heinkel Aircraft Company. Arrived in Japan from Shanghai in November 40. In January 41 reported to be going to Manchuria.
Kempin, Richard	Swiss engineer residing in Yokohama. 1937/38 Director of Oerlikon, Zurich. 1938 - ? In charge of Japanese factories using Oerlikon patents for the manufacture of small arms. (Report dated 11 December 1940.)
Kellerman, Wilhelm	Civil engineer. Left U.S. for Japan in April 41.
Kinze, Victor	Believed to be Lufthansa pilot. Due to arrive in December 40 from South America.
Kreyer, Dr.	Representative of Roechling Stahlwerke, A.G., Tokyo.
Kurata, Rudolph	Mechanic. Left South America for Japan in April 41.
Lackner, Josef	Electrician. Left South America for Japan in April 41.
Lemke	Krupps representative in Japan. Went to Shanghai in February 41.

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Name	Function
Mand, J.	Aircraft technician. Reported in November 41 to be employed by Dai Nippon Airways Co.
Michael, Wilhelm	Representative of I.G. Farben.
Mohr, Bernard	Director Siemens-Schuckert Denki K. K., Tokyo. Personal address as of 13 October 44: 13 N. Chiyomashi Boyaku, Tokyo
Mueller	Ship construction engineer sent to Japan in 1943 to assist the Japanese in U-boat construction.
Nietschke, Gerhard	Engineer and test pilot for Heinkel, Tokyo. Arrived about 10 October 1941.
Noltenius	Representative of Roechling Stahlwerke A.G.
Otte, Ernst	Radio operator. Left South America for Japan in April 41.
Otto, Willi	Electrician. Reported on 22 October 1941 as having recently arrived.
Pachunder, Friedrich	Wireless operator. Reported on 22 October 1941 as having recently arrived.
Puzicha, Kurt	Believed to be Lufthansa Pilot. Due to arrive in December 40 from South America.
Reidl, W.	Managing Director of Johs Rieckermann in Kobe (October 40).
Rippe, Walter	Representative of I.G. Farben
Schaefer, Kurt	Connected with Consugerma Company, Kobe, as of 16 September 44.
Schafer, Kurt O.	Civil engineer. Left U.S. for Japan in April 41.

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Name	Function
Scheuerman, Arno	Representative of I.G. Farben
Schiffner, Eng.	Submarine expert who reached Far East in summer of 1943. Expert in acoustic equipment.
Schlenk, Herman	Representative of I.G.Farben.
Schmidt, Peter Ob. Ing.	Representative of Carl Schmidt, Neckarsulm. Arrived Far East 1943.
Schmidt, W., Dr.	Representative of Deschimag.
Schmidt. Wolfgang	Representative of I.G. Farben.
Schnole, Gerhard	Representative of I.G. Farben.
Schoening, Paul	Marine and aircraft engineer. On 12 November 41 was reported to have arrived recently from South America and to be acting as technical adviser to the German Naval Attache
Schott, Fred	German chemist. In August 40 he left Japan for three months in Shanghai; his return was not noted.
Seifert,	Engineer in Kobe. Head of German-Japanese Industrial Organization.
Singer, Rudolph, Dr.	Living at Omiya. Understood to be doing important chemical research work for the Japanese government. (Rep. of 6/11/40). He is Czechoslovakian.
Stapefeldt, C.H.R.	Civil engineer. Left U.S. for Japan in April 41.
Stoll, Otto	Representative of Bohler Bros. (October 40)

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Name	Function
Tiedemann, H.	German consulting engineer. Reported in July 40 to be making factory plans for Toyo Aluminium, Mitsubishi and Sumitomo. He drew the plans of a factory then being built near Shizuoka. His office: Hon-cho, 3 Chome, Omeri Building, near Honbashi-ku.
Wacker, Franz	Due to sail for Japan from South America in April 41 to be employed as electrical engineer in Manchuria.
Weinert, Erhardt	Engineer. Left South America for Japan in April 41.
Weymayr, Friedrich	Engineer. Left South America for Japan in April 41.
Wickert	"Radio Attache" at the German Embassy in October 41. Not on the diplomatic list.
Wolff, Herbert von	Manager of Kobe agency of Christian Poggensee of Hamburg, exporters of machinery, metals and chemicals.
Zenger, Ing.	Heinkel engineer working in Air Attache's office in Tokyo.

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C. Japanese Personnel in Europe at End of European War who Figured Prominently in Technical Liaison

Name	Function
Abe, Katsuo	Japanese representative on the Tripartite Pact Commission.
Adachi, Takemasa	On staff of Naval Attaché.
Emi, Tetsusiro	On staff of Naval Attaché. Submarine expert.
Fukao, Kenji	Mitsubishi oil refinery expert scheduled to receive training in I.G.Farben hydrogenation process.
Hattori, Sokuro, Major	Expert on machine tools. In U.S. custody.
Ikeda, Haruo	Delivered Japanese naval purchases in Europe. Arrived Europe March 1944.
Iki, Tech. Comdr.	Studied metallurgy at Krupp, Magdeburg, about April 1945.
Imaeato, Kazuo, Comdr.	Member of Japanese Naval Air Force staff.
Inaba, Paymaster Comdr.	Formerly chief accountant for Japanese Navy in Germany. Went to Italy in 1943.
Ishige, Shozo, Col.	Representative of Ministry of War and Ord. Adm. Hdqs. in Germany. Oil expert and specialist in munitions in tank production and use. Negotiated with I.G.Farben for hydrogenation process. Now in U.S.
Ishizuka, Takeo, Lt. Col.	Assistant Military Attaché. Aircraft armament expert trained in manufacture of weapons. Now in U.S.
Kamiya, Chimata	Fuji Electric Company engineer.
Kawakita, Jiro, Major	Arrived Europe March 1944. Studied German rocket and jet propelled aircraft production and technique. Now in U.S.

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Name	Function
Kigoshi, Yasukazu, Major	Raw materials expert.
Kikuchi, Koichi, Major	Japanese Army Air Force staff member.
Kinoshita, Toshisada, Major	Representative of Japanese Fuel Ministry in Germany. Received training in manufacturing high grade lubricating oils at Ruhrchemie in 1941. Now in U.S.
Kitajima, Masamoto	Aircraft engineer.
Kobayashi, Shigeru, Major	Aeronautics expert connected with purchase and investigation of aircraft, aircraft engines, weapons, V-1, etc. Studied electrical percussion cap manufacture at Rheinmetall. Now in U.S.
Kobayashi, Ichiro Lt. Comdr.	Member of Medical Corps.
Kojima, Hideo, Rear Adm.	Naval Attaché. Accompanied Oshima on tour of German military installations. Now in U.S.
Komatsu, Mitsuhiko, Lt.Gen.	Military Attaché. Now in U.S.
Kotani, Etsuo, Col.	Military expert and adviser to Military Attaché in Germany. Arrived in Europe April 1943 as member of Lt. Gen. Okamoto's party. Believed to have specialized in Russian intelligence.
Kuroda, Tech. Capt.	Weapons specialist.
Mikami, Yoshiomi, Eng.	Studied natural and synthetic oil production. Visited Ruhrchemie plants. Was scheduled to receive training at I.G.Farben in hydrogenation process for making synthetic oil. Now in U.S.
Minagawa, Kiyoshi, Tech. Comdr.	Arrived Europe March 1944 as Assistant Naval Attaché. Studied manufacture of missiles. In April 1945 was engaged in studying and experimenting on a castable resin (Geissharz) suitable for making the moulds used in processing light alloys for airplane fuselages at Konstanz under the direction of Prof. Schmidt. Now in U.S

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Name	Function
Nagamori, Capt.	Arrived Europe March 1944. Member of Japanese Naval Attaché office. Handled negotiations for ME-163 and ME-262.
Ochiai, Takeo, Col.	Visited Krupp works and Zeiss plant. Reported new technical developments. In U.S. custody at Bad Gastein.
Ogawa, Sueo, Lt. Col.	Munitions expert.
Omiya, Kitsuo, Col.	Member of mixed commission under Tripartite Pact. Munitions expert. Now in U.S. custody.
Oshima, Hiroshi	Military Attaché Berlin 1934-38. Ambassador to Berlin 1938-39. Reappointed 1940. Now in U.S.
Otani, Osamu, Maj. Gen.	Ranking aviation specialist in Germany. Handled liaison with GAF. Now in U.S.
Sakai, Naoe	Spent 30 years in Europe attached to Japanese Embassy in Berlin.
Sakimura, Shigeshi	Representative of Japanese Iron Control Association. Still in Europe.
Shimamura, Tetsuo	Former member of Japanese Iron Control Association in Berlin. Engaged in negotiations with the Germans for chromadur and tinidur and trained in its manufacture at the Krupp plant at Magdeburg. Still in Europe.
Shimosato, Kazuo	Believed to have received training at Deschimag and Buckau (R.Wolf A.G.) Company in the production of turbines and suction condenser pumps. In April 1945 was engaged in studying special batteries and high quality wood made from sawdust at the Electro Chemical Research Laboratory of Dr. Schmidt at Konstanz. Now in U.S.
Shizuno, Yoshida, Tech. Capt.	Director of Army Air HQ in Italy. Inspected weapon production at the Ansaldo Company in Italy.

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Name	Function
Suematsu, Shigerisa, Lt. Col.	Studied German rocket and jet propulsion technique. Now in U.S.
Suzuki, Tatsushiro, Major	From 1944 a member of the staff of the Army First Air Technical Laboratory and was resident official of the Air HQ. Now in U.S.
Tarutani, Yoshikuchi, Tech. Capt.	Received special training in the manufacture of propulsion equipment for the ME-262, especially the Jumo-004, and has studied jet propulsion in general.
Toyoda, Kumao, Capt.	Assistant Naval Attaché. Said to be in charge of flight training.
Wakuda, Koichi	Machine tool expert responsible for the selection of machine tool parts and the acquisition of drawings.
Yamamoto, Yoshio	Member of the staff of the Naval Attaché.
Yoshinari, Mututaro, Lt. Col.	Instrument and electrical specialist. Now in U.S.
Yoshikawa, Haruo	On the staff of the Naval Attaché.

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D. German Personnel Scheduled for Voyage to Japan at Time of Germany's Surrender

Name	Function
Brandner	Junkers engineer.
Caspar, Victor	Messerschmitt mass production engineer who was scheduled to direct manufacture of the ME-262 in Japan. Formerly employed by Junkers and Focke-Wulf Company as a mass production engineer.
Kessler's Party	It was originally planned to have Gen. Kessler (See Section E) take a small staff with him to Japan to give the Japanese technical and tactical assistance in aircraft matters. As originally proposed, Kessler's party was made up as follows: Haenisch, Dr. - Interpreter. Harke, Tech. Major - Radar and aircraft expert. Mahlfeld - Construction engineer. Mayer, Capt. Menzel, Lt. - Radar and radio-controlled weapons. Sandrart, Col. - A/A expert; general aerial defense. Sauer, Capt. Schubert, Major. Schumann, Oberlt. - A/A guns. Stepp, Lt. Col. Wild, Maj. Gen. Subsequently the party was reduced to eight and then to three. Those three, Kessler, Sandrart and Menzel, left Europe on the U-234 and were captured.
Mueller, Lt. Dr.	Was scheduled to act as interpreter for German Naval officers assigned to duty on Japanese submarines.
Pabst	Mechanic for mass production of ME-262.
Trappeil	Junkers Company jet propulsion engineer trained in manufacture of the propulsion unit of ME-262.

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E. Personnel Lost En Route Between Europe and the Far East or the Far East and Europe

Name	Function
Bringewald, August	Messerschmitt mass production engineer who was to direct manufacture of ME-262 in Japan. Formerly was designing technician and chief of the fuselage and armament section of Henschel Company where he worked on the HS 122, HS 126 and HS 130. Left Europe March 45 on the U-234 and was captured by the Allies when the German submarine surrendered.
Bulla, Richard, Lt.	In December 44 ten German Naval officers were to be sent to the Far East to serve with the Japanese fleet in operation. The objects of this proposal were the improvement of coopera-tion, exchange of experience and the foundation of post-war connections between the two naval services with particular reference to the reconstruction of the German Navy. Only two German naval officers ever left Europe, Lt. Bulla and Oberlt. Heinrich Hellendoorn (see below). Both were on the U-234 which left Europe at the end of March 45 and became prisoners of war when the submarine surrendered.
Chlingensperg, Rolf, von	Messerschmitt engineer scheduled to direct manufacture of ME-163 and 262 in Japan. Lost on U-864 in February 45.
Falck, Gerhardt, Fregattenkapitän	Had engaged in liaison with the Japanese in the construction of electric motors. Was scheduled to be attached to Naval Attaché's office in Tokyo and to assist the Japanese in ship construction and electric welding in aircraft construction. Left Europe on the U-234 and was captured by the Allies.
Kondo, Masatake, Col.	Former Assistant Military Attaché in Italy. Lost en route to Far East in 1943.
Hellendoorn, Heinrich Oberlt.	A/A gunnery expert. Was scheduled to serve with Japanese fleet in operation. (See Bulla)

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Name	Function
Kessler, Ulrich, Genobst.	Was scheduled to replace Major Gen. von Gronau as Air Attaché in order to bring about better liaison between Germany and Japan in aviation techniques. Left Europe March 45 on the U-234 and was captured by the Allies when the German submarine surrendered.
Menzel, Erich, Oberlt.	Member of Kessler's party and expert on radar and radio-controlled weapons, especially the HS 293 remotely controlled bomb. Left Europe March 45 on the U-234 and was captured by the Allies when the submarine surrendered.
Miura, Hiroshi, Lt. Col.	Former Army surgeon attached to Military Attaché's office in Berlin. Lost June 43 en route to Far East.
Nakai, Toshio	Received training in Germany in manufacturing fuels for ME-163. Lost en route to Japan in 1945.
Nieschling, Kay, Geschwader Richter	Scheduled to act as a Naval Judge in Tokyo under Adm. Wennecker. Left Europe March 45 on the U-234 and was captured by the Allies when the submarine surrendered.
Ruf, Franz	Mechanic in the mass production of the ME-262. Messerschmitt Company's chief technical expert in the manufacture of jig tools. Was to have supervised the construction of a ME-262 factory in Japan. Left Europe March 45 on the U-234 and was captured by the Allies when the submarine surrendered.
Sandrart, Fritz, Oberst.	Member of Kessler's party. Tactical anti-aircraft officer who was to advise the Japanese on defense of their cities. Left Europe March 45 on the U-234 and was captured by the Allies when the submarine surrendered.
Schlicke, Heinz Sonderführer-Korv.Kapt.	A technical specialist in the field of radar and infra-red. Was to report to Japan all developments in this field in Germany. Left Europe March 45 on the U-234 and was captured by the Allies when the submarine surrendered.

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Schomerus, Riclef	Messerschmitt Company engineer who was scheduled to assist the Japanese in the development of jet propelled aircraft. Was especially trained in the manufacture of turbine-blades for the ME-262. Lost en route to Japan in February 45.
Shoji, Tech. Comdr.	Jet-propelled and rocket-propelled aircraft technician. Left Europe in March 45 on the U-234 and committed suicide when that submarine surrendered to the Allies.
Tomonaga, Hideo, Lt. Col.	Reached Europe in summer of 1943 and studied German submarine construction. Left Europe March 45 on the U-234 and committed suicide when the submarine surrendered to the Allies.
Yamato, Tadao	On the Japanese Naval Air Force Staff. Expert on electrical equipment.

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TAB C

FIRMS AND INSTITUTIONS IN JAPAN ASSOCIATED

WITH TECHNICAL EXCHANGES

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FIRMS IN JAPAN ASSOCIATED WITH TECHNICAL EXCHANGES

Name of Firm	Address	Activity
Aichi Koku K.K.	48 A Inanaga Shinden, Minato ku, Nagoya, Aichi ken	Aircraft manufacture
Anshan Steel Works	Seitetsu Kojo Chi Ku, Anshan City, Fengt'ien Province, Manchuria	Steel production
Aviation Research Arsenal (Navy) (Yokosuka Air Technical Depot?)	No record of address available	Aircraft development, Jet and rocket propulsion.
Carl Zeiss	20 Marunouchi, 2 chome, Kojimachi ku, Tokyo	Optical glass and cameras.
Dai Nippon Air-transport K.K.	1 Yuraku Cho, 1-Chome, Kojimachi, Tokyo	Commercial Airway
Dai Nippon Kali Kagaku K.K.	Teihoku Life Insurance Building, 1 Marunouchi, 1 chome, Kojimachi ku Tokyo	Japan agents for Phosphate D'Alsace.
Fokkes & Koch	11, 14 Marunouchi, 2-Chome, Kojimachi Ku, Tokyo	Importers. Engineering equipment, aircraft engines
Fuji Denki K.K.	1 Tanabe Shinden, Kawasaki, Kanagawa	Radar and radio manufacture
Furukawa Denki Kogyo K.K.	8 Marunouchi, 2 chome, Kojimachi ku, Tokyo	Electrical apparatus, light alloy castings.
Furukawa Metal Industry K.K.	8 Marunouchi, 2 chome, Kojimachi ku, Tokyo	Light metal alloys, alloy castings, aircraft propellers.
Hitachi Seisakusho K.K.	12 Marunouchi, 2-Chome, Kojimachi Ku, Tokyo City	Electrical apparatus, aircraft components.

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Name of Firm	Address	Activity
Hokaido Jinzo Sekiyu K.K. (Subsidiary of Nippon Jinzo Sekiyu K.K.)	7 Odori Nishi, 3chome, Sapporo, Shicho, Hokaido	Synthetic lubricating oil.
Ikuta Laboratory	No record of address available	Electronic research
Illies and Co. (Tokyo agent for numerous German manufacturers)	1 Marunouchi, 1 chome, Kojimachi ku, Tokyo	General merchandise, aircraft and engineering components and manufacture. Synthetic oil and processes.
Kawanishi Hikoki K.K.	1 Daito, Naruo Mura, Muko Gun, Hyogyo Ken	Aircraft manufacture
Kawasaki Kokuki Kogyo K.K.	6 Yadayama Dori, 1 chome, Hayashida ku, Kobe	Aircraft and aircraft engines.
Kawasaki Laboratory	No record of address available	Electronic research
Kyusku Hikoki K.K.	254 Mugino, Naka Mura, Chikushi Gun, Fukuoka Ken	Aircraft manufacture
Manshu Hikoki Seizo K.K.	111 Choangai Daito, Hoten, Fengt'ien, Manchuria	Aircraft and aircraft engines.
Miitaka Laboratory	No record of address available	Electronic research
Mitsui Bussan K.K.	1 Marunochi, 2 chome, Nihonbashi ku, Tokyo	Engineering plant and equipment, processes, patents and manufacturing rights, raw materials, synthetic oils.
Mitsubishi Denki K.K.	4 Marunouchi, 2 chome, Kojimachi ku, Tokyo	Radar and radio manufacture
Mitsubishi Shoji K.K.	10 Marunochi, 2 chome, Kojimachi ku, Tokyo	Engineering plant and equipment, processes, patents and manu-

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Name of Firm	Address	Activity
		facturing rights, raw materials, aircraft, aircraft engines and components
Nagoya Arsenal (Navy)	No record of address available	Aircraft armament
Nakajima Hikoki K.K.	4 Marunouchi, 3 chome, Kojimachi ku, Tokyo	Aircraft and aircraft manufacture
Nihon Gakki K.K.	250 Nakazawa-cho, Hamamatsu, Shizeoaki en	Aircraft and aircraft components, propellers.
Nihon Musen Denshin K.K. (Subsidiary of Nippon Musen K.K.)	930 Kami Renjaku, Mitaka Mura, Kitatama Gun, Tokyo	Radar and radio manufacture
Nippon Chisso Hiryo K.K. Konan Korea	1 Soze Cho, Kita Ku, Osaka City. The address of the Konan Plant of this company is: Konan O, Kanshu Gun, Kankyo Nando, Korea.	Heavy chemicals, fertilizers, hydrogen peroxide, oxygen, nitrogen, acids.
Nippon Kokan K.K.	2 Marunouchi, 1-Chome, Kojimachi Ku, Tokyo	Steel pipes, etc.
Okayama Laboratory	No record of address available	Electronic research
Okura Shoji K.K.	2 Ginza, 2 chome, Kyobashi ku, Tokyo	Engineering equipment, manufacturing rights and processes
Showa Iron Works	5 Ginza, 1-Chome, Kyobashi Ku, Tokyo City	Steel and iron production
Siemens Schuckert Denki K.K.	2 Marunouchi, 3-Chome, Kojimachi Ku, Tokyo	Agents for Siemens Schuckert electrical equipment.
Sumitomo (There is no evidence as to which of the Sumitomo subsidiaries is actually concern-	The head office of Sumitomo is believed to be 60 Minami cho, Okashima Konohama ku, Osaka	Aircraft components, light metal production, steel processes, manufacturing rights.

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Name of Firm	Address	Activity
ed in technical exchanges. The parent company of Sumitomo group is Sumitomo Jukogyo K.K. Subsidiaries likely to be concerned are one or more of Sumitomo Kinzoku K.K. Sumitomo Aluminum K.K. Sumitomo Kwagaku Kogyo K.K., or Sumitomo Kogyo K.K.		
Tama Military Technical Laboratories	No record of address available	Electronic research
Tokai Denkyoku K.K.	6 Marunouchi, 1 chome, Kojimachi ku, Tokyo	Carbon electrodes and electrode manufacturing process.
Tokyo Teikoku Daigaku Koku Kenkyujo (Tokyo University Aeronautical Institute)	No record of address available	Aeronautical Research
Tsukaguchi Laboratory	No record of address available	Electronic research
Yamamoto Shokai K.K.	3 Ginza, 2-Chome, Kyobashi Ku, Tokyo	Import and manufacture of textile and other machinery

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TAB D UNCLASSIFIED

DATA ON JET- AND ROCKET-PROPELLED AIRCRAFT; JET- AND ROCKET-PROPULSION UNITS AND FUELS

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ME-163 B **Duties:** Interce

Development: This "hot" version was developed from the earlier A "cold" subtype, as a fast-climbing, short-range interceptor for operations against daylight heavy bomber formations in defense of specific targets. The A subtype was relegated to training duties.

Sub-types: The ME-163 B-1 is the common operational subtype.

Description: Single-seat flying wing design of mixed metal and wood construction. The wing, of wood with plywood skin, is of special, sharply, swept-back design, and carries "elevons"--serving the dual function of elevators and ailerons--outboard near the rounded tips. The very short fuselage, of teardrop shape, is deep in relation to its length and is of metal construction. The rear portion, containing the rocket unit, is detachable. The tail unit has only vertical fin and rudder, no horizontal surfaces.

Dimensions(ft): Span: 30.6 Length: 19.4 Wing area (sq ft): 186

Weights(lbs): Normal take-off: 9,500

Power plant: One Walter HWK 109-509 bi-fuel (T-and C-Stoff) liquid-rocket unit.

Armament: 2 x MK-108 (one in each wing root) with 60 rounds per gun.

Performance: Max speed: 515 mph at S.L.; 558 mph at 13,000-39,500 ft.
Rate of climb: To 40,000 ft. in 2.6 mins.
After climb to 40,000 ft. duration of powered flight is 4-6 mins.

Remarks: Take-off (at 170 mph) is made on wheeled undercarriage which is then jettisoned. Climb at 50°-60° at about 440 mph. Landing is effected on a skid, with a landing run of about 1,300 ft. Landing is not an easy manuever and requires considerable skill; it should not be attempted with a fuel load, which will explode in the event of a crack-up. The aircraft should always be landed on a grass surface. Due to the explosive nature of the fuel, take-off is not without danger to the pilot; if not airborne at a certain point on the take-off run, the pilot must bale out to avoid the inevitable explosion when the aircraft crashes at the end of the runway.

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According to German test pilots the bad features of the ME-163 are: (i) instability in high-speed flight; (ii) limited endurance restricts operating range, and results in landing problems because of difficulties in reaching appropriate bases; (iii) not suitable for flying by night or under windy conditions; (iv) lateral instability because narrow track undercarriage and high C.G. produces tendency to nose over; (v) difficulties in holding aircraft in a straight line on take-off; (vi) engine failure is common; (vii) entry of steam into the cockpit fogs the windshield; and (viii) angle of climb is so steep that aircraft instruments do not function properly.

The power unit (which weighs about 420 lbs) is in two main assemblies. The forward one consists of a housing for the turbine; two worm type pumps for delivering the fuel; a control unit; pressure-reducing valve; and an electric starter motor. A small cylindrical unit attached to the forward housing, by the action of a solid catalyst on the T-Stoff, produces steam to drive the turbine. The second assembly consists of the combustion chamber. The fuel tanks hold about 226 gallons of T-Stoff, 110 gallons of C-Stoff.

Flight endurance can be increased by alternating powered and gliding flight.

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ME-163 C   Duties: Interceptor.

Development: Variously referred to as the ME-163 C ME-263, JU-248, this aircraft was developed from the ME-163 B and incorporates improvements found necessary for operational and production reasons. Production was turned over by Messerschmitt to Junkers.

Description: Although bearing a strong resemblance to the ME-163 B, the C subtype was cleaned up to give a greatly improved streamline form. The fuselage, which is much slimmer, from the nose to the wing trailing edge is of projectile form, symmetrical about the longitudinal axis. A pressurized cockpit is fitted. A retractable tricycle undercarriage replaces the skid of the B subtype. Increased fuel tankage--352 gallons of T-Stoff, 185 gallons of C-Stoff--together with modified power unit give increased powered flight endurance.

Dimensions(ft): Span: 32.2   Length: 23.1   Wing area (sq ft): 197

Weights(lbs): Normal take-off: 11,280

Power plant: One HWK 109-509 C, having an auxiliary cruising jet, smaller than the main jet, positioned immediately below it in the tail. Total thrust 4,400 lbs.

Armament: 2 x MK-108 (one in each wing root) with 75 rounds per gun.

Performance: Max speed: 590 mph at 13,100-39,300 ft.
Service ceiling: 52,500 ft.
Rate of climb: To 40,000 ft in 3 mins
Total powered flight 15 mins (1 min take-off, 2 mins climb, 12 mins at altitude).

Remarks: Suffers from many of the flight difficulties of the B subtype; the tricycle undercarriage, however, leads to better lateral stability at take-off. The C subtype was to be fitted with a parachute brake, which, with the tricycle undercarriage, reduces the landing run to 650 ft.

There is no indication that the ME-163 C was ever used operationally.

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Liquid Rocket Chemical Fuels

The Walter power unit of the ME-163 required special liquid chemical fuels. Those fuels were:

T-Stoff: Concentrated hydrogen peroxide, at a concentration of 80-85%.

B-Stoff: Hydrazine hydrate.

C-Stoff: A solution of B-Stoff in water and methanol.

Z-Stoff: An aqueous solution of zinc in potassium or calcium permanganate used in the early version of the Walter power unit. It was later replaced by the more satisfactory C-Stoff and was then used only for launching the V-1.

D-86: A cement made by mixing potassium dichromate, potassium chromate, potassium permanganate, caustic potash and high-grade Portland cement, used as a catalyst for the decomposition of T-Stoff.

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Production of T-Stoff:

Hydrogen peroxide received far wider attention in Germany during the past eight years than anywhere else in the world, both as regards the investigation of its properties and application and the development of large-scale methods of production. T-Stoff, the 80-85% concentrate, was produced from the standard commercial 30-35% peroxide. Concentration was achieved in special fractionation and distillation columns. The 30-35% peroxide was manufactured by hydrolysis with live steam of potassium persulphate, and the vapors from the hydrolysis rectified and condensed to form the low concentrate porduct. The product of the standard persulphate process was not pure enough for direct concentration and was therefore distilled in a bulk evaporator, the vapor being fractionated in a normal pedked fractionating column to give the high concentration material. In some cases the material was distilled a second time for even greater purity.

An absolute pressure of 40-50 mm was maintained in the steam-heated retort of the concentrating equipment. The concentrating equipment was made throughout of stoneware except for the condenser which was of aluminum. Stainless steel was used for ancillary equipment; all stainless steel surfaces were kept highly polished.

The 30-35% peroxide usually contained about 2 grams per liter of sulphuric acid; this was neutralized with ammonia until a concentration was reduced to 0.5 grams per liter. At that point a stabilizer was added and the stabilized solution fed continuously into the concentrating retort. The vapor leaving the retort was 30% peroxide and 70% steam. All of the impurities remained behind in the retort--one of the principal reasons for the stability of the concentrated product. The vapors from the retort were passed through a rectifying tower from which a 65% concentrate was obtained. That product then entered a second retort for further concentration; here an 80% concentrate was obtained and drawn off. The high concentrate product was cooled and transferred to storage tanks and stabilized by the addition of phosphorous acid.

The high purity achieved was necessary chiefly for stability and storage reasons but also was very essential in cases where the peroxide was to be used in conjunction with a solid catalyst, in which case deposition of residues would poison the catalyst.

The concentrated product had a high degree of stability. When stored in pure aluminum tanks outdoors, the loss in twelve months was as low as 2%.

Transportation of the concentrated peroxide as well as storage was carried out in containers of aluminum of a high degree of purity (99.5 - 99.8%). All aluminum surfaces coming into contact with the concentrated peroxide had to be treated most carefully; any impurity or contamination would result in decomposition of the peroxide. All distilled water used in the manufacturing plant was obtained from aluminum, stainless steel or stoneware containers; the least trace of copper, such as might be produced by a copper container, was exceedingly deleterious.

Manufacture of B-Stoff:

The manufacture of hydrazine hydrate was effected in Germany by the reaction in water solution of ammonia with sodium hypochlorite. Actually three concurrent reactions were involved in the process: in the first chloramine was formed from the reaction of ammonia with sodium hypochlorite; in the second chloramine and ammonia produced hydrazine; and in the third, hydrazine and water produced hydrazine hydrate.

The manufacture was an exceptionally difficult one because the formation of hydrazine hydrate proceeded slowly and there was a strong tendency for the hydrazine to react with chloramine as fast as it was formed, with the production of nitrogen and ammonium chloride. That difficulty was successfully overcome by (i) speeding up all the stages of the reaction as far as possible by the application of heat and pressure, and (ii) the use of inhibitors, such as iron or copper sulphate, in very small amount. Those catalysts were successful in impeding the decomposition reaction, but must not be present in quantities great enough to permit them to react themselves. That was further protected by the use of albumin, lime or casein-- of which albumin is preferable-- as an additional inhibitor to prevent attack on the copper or iron salts.

In the German process the formation of hydrazine was favored by very rapid heating to 160° C (allowable heating time one second). That temperature required a pressure of 30 atmospheres to maintain liquid phase conditions. The reacted mixture was then immediately expanded to atmospheric pressure, which flashed off most of the excess ammonia and froze the hydrazine in the remaining salt solution in the form of a 1% concentration of hydrazine hydrate. Subsequent operations consisted primarily in salt removal and concentration of the hydrazine hydrate to 80-100% strength (average 91-92%) by multi-stage evaporation and fractionation.

As might be expected, the operation was replete with practical problems which made it anything but the simple process indicated by the

primary chemistry involved. Ammonia, sodium hypochlorite and hydrazine are corrosive to many and differing construction materials, with the result that almost the entire plant had to be constructed of stainless steels and ceramics. Only the ammonia system could be made of ordinary steel.

The raw materials used were ammonia, caustic and chlorine. As practiced in Germany, the steam and water requirements were relatively large. The relative amount of stainless steels used in German plants was large, the estimate being as much as 1,000 tons of such materials in a unit producing 100 tons per month of hydrazine hydrate.

Production of C-Stoff:

To produce C-Stoff, hydrazine hydrate was dissolved in a mixture of methanol and water and mixed with a reaction catalyst--potassium copper cyanide. The usual concentration was 30% hydrazine hydrate, 14% water and 56% methanol. Four-six grams per liter of potassium copper cyanide were added as a reaction catalyst.

Production of Z-Stoff:

Sodium and calcium permanganate were manufactured in Germany by passing potassium permanganate through a sodium or calcium zeolite (alumino silicate), giving sodium or calcium permanganate. The potassium permanganate was separated and filtered out in the process; to insure its complete removal the solution was cooled to -10° C and refiltered. The product was then diluted to the desired concentration and stored in iron vessels.

Transportation and storage:

The transportation and storage of the liquid rocket chemical fuels require special precautions because of problems of corrosion. Tanks of aluminum of a high degree of purity are suitable for T-Stoff. For the large-scale transportation and storage of B-Stoff and C-Stoff metallic containers must be lined with oppanol or enamel lacquer. Synthetic rubber linings also are suitable for B-Stoff transportation, as are containers of chromium nickel steel.

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ME-262 Duties: Fighter/ground-attack/recce

Development: Designed in 1938, the ME-262 was first flown in 1940 with Jumo-211 engines. The airframe proving satisfactory, the prototype jet-powered aircraft flew in 1942, with Jumo-004 A units. The V-6 (with Jumo-004 B's) appeared in 1943 and the V-9, the forerunner of the production aircraft, in 1944.

Sub-types: The A-1 (with 4 guns) is regarded as a fighter, and the A-2 (with 2 guns) as a bomber, although some A-1's were used for bombing and reconnaissance. A two-seater night-fighter version was under development.

Description: All-metal monoplane. The wing has a sharp sweep-back and is fitted with all metal ailerons and slotted flaps. The fuselage, made in four sections, has a nose cone of steel construction which houses the guns and ammunition. Retractable tricycle undercarriage; single fin and rudder. Power units underslung under wing. Pilot's cockpit at mid-fuselage.

Dimensions(ft): Span: 41.0 Length: 34.8 Wing area (sq ft): 234

Weights(lbs): Normal take-off: 13,430 Maximum: 15,290

Power plant: 2 x Jumo-004 B-2 turbo-jet units

Armament/Bomb Load: A-1: 4 x MK-108 (fixed nose) with 100-80 rds per gun.
A-2: 2 x MK-108 (fixed nose)
2 x 250 kg (or 1 x 500 kg) externally slung under fuselage.
(Drop tanks can be fitted to the bomb-carriers).

Performance: Max speed: 472 mph at S.L.: 528 mph at 23,000 ft.
Service ceiling: 39,400 ft.
Rate of climb: To 26,300 ft. in 11 mins.
Flight endurance is 45-50 mins at low altitude; 60-90 mins at high altitude.

Remarks: The carrying of an external bomb-load by the A-2 version reduces performance date (as given above for the A-1) by 5-10%. The merits of the ME-262 lie in its high speed and heavy armament, its demerits in its lack of maneuvrability, relatively short range and the extreme vulnerability of the jet units, which tend to catch fire very readily if hit in aerial combat.

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Landing speed is 155 mph; stalling speed with full load about 120 mph. Because of inferior structural workmanship, it was not infrequent for parts of the ME-262 to be stripped off in a steep, fast dive. The ME-262 functions efficiently on one jet unit; landing on one unit is possible although not preferable.

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AR-234 Duties: Bomber/recce.

Development: The B-subtype--the first production model--first flew in December 43, and went into production, after very little modification, in June 44. This subtype was used operationally on a small scale both as a tactical bomber and as a reconnaissance aircraft.

Sub-types: The A-subtype, from which the B was developed, had a jettisonable undercarriage and landed on skids; it was not put into quantity production. There were two versions of the B-subtype, the B-1, a reconnaissance type, and B-2, a bomber type.
C and D subtypes were under development--see "Remarks" below.

Description: All-metal high wing monoplane with underslung jet-units. Wing has square cut tips with rounded corners. Cockpit set well forward in rounded nose fitted with many transparent surfaces. Single fin and rudder. Retractable tricycle undercarriage, with main wheels of very narrow track. Periscopic bombsight and triaxial automatic pilot fitted to bomber version. Fuselage skin has very smooth finish.

Dimensions(ft): Span: 47.3 Length: 41.6 Wing area (sq ft): 298

Weights(lbs): Normal take-off: 18,500 Maximum: 19,500 (22,000 with assisted take-off).

Power plant: 2 x Jumo-004 turbo-jet units.

Armament/Bomb Load: 2 x MG-151/20 fixed firing aft (250 rounds per gun).
Bomb stowage: 1 x 2,200 lbs under fuselage; 1 x 1,100 lbs under each jet unit (drop tanks alternative).

Performance: Max speed: 472 mph at 19,000 ft. (440 mph with bomb load).
Service ceiling: 37,700 ft.
Rate of climb: To 26,200 ft in 18 mins (34 mins with bomb load).

Remarks: Good performance on one engine, including landing, is claimed. Parachute tailbrake fitted to reduce landing run; take-off run is 1,950 yards with 3 x 500 kg bombs (940 yards with assisted take-off rockets).
C-Subtype: Under development; powered by a pair of BMW-003's under each wing. C-1: Recce version; 2 x MG 151/20; max-speed 543 mph; service ceiling 40,700 ft. C-2: Unarmed bomber; max speed 555 mph at 19,700 ft; range 472 miles with 4,400 lbs of bombs; service ceiling 35,400 ft. C-3: Bomber; 2(or 4) x MG 151/20; max. speed 487 mph at 19,700 ft. with 4,400 lbs of bombs;

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flight endurance 50 mins with 4,400 lbs. of bombs, 110 mins with 1,100 lbs. of bombs. C-4: Recce version; 2 x MG 151/20; flight endurance 130 mins (maximum); max. speed 525 mph at 33,000 ft.
D-Subtype: Projected development with 2 x Hirth HeS-011 jet-units. Stated max. speed 525 mph at 29,500 ft. with 1,100 lbs of bombs.

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HE-162 Duties: Fighter

Development: Popularly known as the "Volksjäger" (people's fighter), the HE-162 was designed to employ as little as possible of material in short supply. The design was accepted by Goring on 23 September 44; designing work began the following day, and blueprints were completed by 5 November. The first aircraft was ready by, and the first test flight flown on, 6 December 44.

Sub-types: The A-1 was the standard service version at the collapse.

Description: Shoulder-wing monoplane of mixed construction; wing, tail fins and rudders of wood, fuselage of duralumin, steel, dural and wood. Tailplane, with dihedral, carries rectangular fin and rudder at each extremity. Retractable tricycle undercarriage using main wheels of the same type as that used in the ME-109. Turbo-jet unit mounted centrally and above fuselage, exhaust jet passing over tailplane and between fins. Single-seat cockpit set well forward.

Dimensions(ft): Span: 23.6 Length: 29.7 Wing area (sq ft): 120.

Weights(lbs): Normal take-off: 5,480 Maximum: 5,940

Power plant: 1 x BMW-003 E-1 turbo-jet unit (Jumo-004, HeS-011, BMW-003 E-2 may alternatively be fitted). A quick power-plant change is possible.

Armament/Bomb Load: 2 x MK-108 (50 rounds per gun) or 2 x MG-151/20 (120 rounds per gun)) mounted low in fuselage sides.

Performance: Max speed: 490 mph at S.L.; 522 mph at 19,700 ft: 495 mph at 36,000 ft.

Service ceiling: 39,400 ft.
Rate of climb: To 19,700 ft. in 6.6. mins
Range: 410 miles at 36,000 ft (normal fuel)
620 miles at 36,000 ft (maximum fuel).

Remarks: The performance figures given above are official figures, but were not attained by the early production aircraft.
Was operational only in very limited numbers.

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JU-287 Duties: Jet-propelled bomber

Development: First seen on April 44 photographic cover of Rechlin, the JU-287 had not progressed beyond the prototype stage; it was, however, the first jet-propelled heavy bomber to fly.

Description: The JU-287's most striking characteristics are the length of the nose of the fuselage and the 25° sweep forward of the wing. The full crew was to comprise pilot, navigator/bomb-aimer, and radio operator/gunner. Ultimately to be propelled by two large turbo-jet units of 5,500-7,000 lbs. thrust each, the prototypes were powered by various arrangements of four or six BMW-003 A-1's (1,760 lbs thrust each).

Dimensions(ft): Span: 66.0 Length: 60.0 Wing area (sq ft): 628

Weights(lbs): Normal take-off: 4?,500 Maximum: 53,000

Power plant: 4 (or 6) x BMW-003 turbo-jet units; arrangements varied in groups of three under each wing, or groups of two under each wing and one low down on each side of nose.

Armament/Bomb Load: Twin MG-131 in remotely controlled tail turret
Bomb-load: 4,400 lbs (normal), 9,900 lbs (maximum).

Performance: Max speed: 509 mph at S.L.; 537 mph at 16,420 ft.;
487 mph at 36,100 ft.
Rate of climb: To 32,800 ft. in 33 mins.
Range: 985 miles with 8,800 lbs of bombs.
1,375 miles with 4,400 lbs of bombs.

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Jumo-004 (109-004)

History:

Junkers carried out some preliminary work on jet propulsion in 1937; at the end of 1939 they began design of a full scale turbo-jet unit. Construction of the Jumo-044 A was begun early in 1940 and the first unit was run at the end of that year. Several units of that type were ready in the summer of 1941, at the end of which year first flight tests were made, using an ME-110 as a flying test bench. The B subtype was designed at the end of 1941 and embodied several modifications. The first unit of that subtype ran at the end of 1942; in the early summer of 1943 a prototype ME-262 with those units was flown. Large-scale production was planned to start in the summer of 1943, but was not fully achieved until May or June 1944.

Type:

8-stage axial-flow compressor with single stage turbine.

Subtypes:

A subtype: First mass production unit with 1,848 lbs thrust.

B-1 subtype: An improved type of compressor and with thrust of 1,980 lbs. Unit had a life of 25 hours.(30-40 flights) between overhauls.

B-4 subtype: Same as the B-1 but with hollow blades and an overhaul life of 35 hours.

C subtype: Designed but not built.

D-4 subtype: 2,200 lbs thrust and overhaul life of 50-75 hours. Designed and planned for mass production in June 45. Fitted with new and better governor and exhaust pipe.

H subtype: Design of this 4,000 lbs thrust unit was completed and construction started just before the collapse.

Compressor:

The light alloy compressor casing is built in two halves and bolted together. The compressor rotor consists of 8 light alloy disks; all blades also are of light alloy.

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Combustion chambers:

More trouble was experienced with combustion chambers than any other part of the unit. There are six chambers disposed radially around the central casting which carries the rear compressor and turbine shaft bearings; each chamber has a fuel injector which injects fuel upstream. The chambers are built up from aluminized mild steel sheet, a special method having been developed for resistance welding of the seams. If the burners go out in flight, the pilot must descend to 13,000 ft. to reignite; at altitudes above 26,000 ft. full speed flight must be maintained to preserve combustion.

Turbine:

There are 61 turbine-blades, fixed into the disk by a forked blade root and secured in position by rivets or, alternatively, the blades may be silver soldered to the rotor. Because of a scarcity of alloying materials and the time required for machining the first solid blades, the turbine was designed to use hollow air-cooled blades which are manufactured by a deep-drawing process from circular sheet metal. The blades are brazed and pinned onto the wheel. Tinidur or chromadur was used for turbine-blades.

Tail pipes:

The tail pipe contains a moveable "bullet" operated by a servo-motor through the throttle lever and capable of moving longitudinally.

Lubrication:

Oil is carried in an annular nose tank. A diluted standard oil was used; without dilution the oil is too heavy.

Starting system:

A Riedel 2-cylinder, 2-stroke starter engine is mounted in the air intake coaxially with the compressor shaft. This engine, of 10 hp, can be started electrically from the cockpit or by hand by means of a cable and pulley.

Other data:

Air temperatures at the entrance and exit of the turbine stage respectively were 850° C and 650° C. Experimentally attempts have been

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made to increase the thrust of the unit by after burning, with which turbine exit temperature was 1,000° C.

The unit was designed to operate on gasoline, but was diverted to fuel oil or centrifuged crude oil operation; on those oils the unit operated satisfactorily, except that the spark plugs became dirty.

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BMW-003 (109-003)

History:

Preliminary work on jet propulsion was started by BMW in 1934; work on the BMW-003 project began in 1939 and the unit first ran in August 40.

Type:

7-stage axial compressor with single stage turbine.

Combustion chamber:

The combustion chamber is a straight-through annular type with 16 burners and 6 auxiliary burners for starting. The chamber is made of Sicromal or, alternatively, aluminized steel.

Turbine:

The air-cooled hollow turbine blades are of well thought-out design which reduces losses introduced by the use of cooling air. The design is adaptable to quantity production by means of inexpensive punch press methods. The blades are welded to the turbine rotor. They hardened and cracked after about 50 hours bench running and were considered to be the limiting factor on the life of the unit.

Exhaust unit:

A variable area exhaust nozzle is electrically operated by a 4-position switch in the cockpit.

Starting system:

A Riedel starter is used, as with the Jumo-004. Starting in the air can be carried out only at altitudes below 10,000 ft. and at speeds approaching 250 mph.

Subtypes:

A-1 and A-2: These were in series production and had a static thrust of 1,760 lbs.

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C subtype: This type, with a compressor of Brown-Boveri design and manufacture, had a thrust of 1,980 lbs.

D subtype: Only preliminary design calculations were made for this subtype, which was to meet the order received from the German Air Ministry in April 45 to improve performance to 2,420 lbs. thrust.

E subtype: The E-1 and E-2 are identical respectively with the A-1 and A-2 series except that engine mounting is changed to fit the HE-162 installation.

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HeS-011 (109-011)

History:

The Heinkel-Hirth turbo-jet unit program began in 1936; up to 1944 there were three experimental units and six projected units. The HeS-3 unit was installed in the HE-178 aircraft and made the first jet-propelled flight in Germany. The HeS-11 (later known as the HeS-011) was begun in 1944, culminating in the series produced unit.

Description:

The unit has an impeller at the intake; a compressor consisting of a diagonal stage and 3 axial 2-stage turbine with hollow blades. An adjustable jet nozzle is fitted, having 2 positions, fully in for idling and fully out for all other conditions. The unit appears to have been carefully designed to provide the necessary air cooling and readiness of manufacture.

The designers reported the greatest difficulty with combustion or fuel jet and burner design and with the control of gas temperature at the turbine entry. Difficulties were also encountered with the impeller. The unit did run for a certain time at a thrust of 2,640-2,860 lbs. but much work was still to be done on the unit at the end of the war.

The unit has the same weight as the Jumo-004 but produces a static thrust 50% greater. Production of the Heinkel-Hirth unit was intended for the end of 1945.

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The V-1 and Piloted V-1

The V-1 was developed as an expendable pilotless aircraft intended for long-range bombardment of towns in Southern England. It is a mid-wing monoplane with single fin and rudder, the rear portion of the fuselage being surmounted by an Argus jet unit.

Light metal is used for the extreme nose of the fuselage; all control surfaces, and the rest of the airframe are of steel. For ease of transport and assembly, the fuselage is made in sections which bolt together.

A steel cylindrical fuel tank of 130 gallon capacity comprises the central section of the fuselage. Behind the fuel tank is a compartment containing two wire-wound spheres 1 ft. 9 1/4 ins. in diameter, containing air under very high pressure. Further aft is a compartment housing the automatic pilot, and the fuselage terminates in a cone carrying the tailplane and rudder.

The propulsion unit comprises a new form of athodyd (aero-thermodynamic duct), actually an impulse duct machine. At the front is a grill containing twelve jets and an arrangement of shutters which close when the pressure within the tube is greater than that in front of the grill.

The engine operates intermittently in conformity with the opening and closing of the shutters, but the fuel supply is continuous. Low-grade aviation fuel is used and is forced from the tanks to the jets by compressed air from the spherical pressure bottles.

A rudder and two differentially acting elevators comprise the control surfaces. The weight of the warhead and the blast effect produced are comparable with those of a one-ton bomb.

A minimum range of 125 miles, 350 mph. speed in level flight and an approach altitude of about 2,000 ft. are attributed to the V-1.

The weapon is launched from a ramp, hydrogenperoxide and permangenate being used as a propellant. (In the late days of the attack against England some V-1's were air-launched.

<u>The piloted V-1</u>: This aircraft is slightly larger than the V-1 and incorporates several changes. The control assembly has been

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removed and the single air tank is moved about two feet to the rear; the warhead is covered with a rounded, blunt, plywood nose case, the cockpit controls and flight instruments are located just forward of the propulsion unit, and ailerons have been added to the wings.

Piloted V-1's were intended to be launched from bomber type aircraft. While the pilot was equipped with a parachute, P/W technicians have stated that only 1% were expected to survive. The aircraft was to be flown to and directed into the target and then the pilot was to jump just before the collision.

Dimensional Data

	V-1	Piloted V-1
Length of fuselage	21' 10"	24' 3"
Length of jet propulsion unit	11' 3"	12'
Max. diam. of fuselage	2' 8 1/4"	2' 9"
Wing span	16'	18' 9"
Gross wing area	55 sq. ft.	

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TAB E

DATA ON CONVENTIONAL AIRCRAFT

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AR-196 **Duties:** Fighter/recce/light-bomber

Development: Standard fighter/recce aircraft of the GAF. Designed for catapult operation from warships (which could carry up to 4 aircraft) and shore bases. Intended primarily for recce, also used for attacks on enemy long-range aircraft and for anti-submarine operations. Twin float version standard, although single float version also exists.

Sub-types: Sub-types A, B and C have been identified.

Description: Single-engine two-seater low-wing monoplane. Wings designed to fold. Single fin and rudder set well forward with respect to tailplane. Transparent cockpit. Fuel carried in floats. Mixed construction--metal, stressed skin, fabric.

Dimensions(ft): Span: 41.0 Length: 36.1 Wing area (sq ft): 307

Weights(lbs): Normal take-off: 6,600 Maximum: 6,800

Power plant: BMW 132K, 9 cylinder, air-cooled radial (920 h.p. at S.L.)

Armament/Bomb Load: 1 x 7.9 mm fixed forward fuselage
2 x 20 mm fixed wing
Twin 7.9 mm flexible dorsal
220 lbs (max. stowage)

Performance: Max speed: 195 mph at S.L.
Service ceiling: 21,500 ft
Rate of climb: 6,000 ft in 4.5 mins.
Range: 540 miles at 120 mph (with 220 lbs bombs)

Remarks: Bomb carriers under wings. Aircraft stressed for catapult launching. Maximum speed of pull-out from dive is 316 mph.

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DO-217 Duties: Bomber/recce/night-fighter

Development: The DO-217 E was the earliest operational subtype of the DO-217 and was developed from the DO-17 Z and the DO-215.

Sub-types: J--night-fighter version (structurally similar to E, except for redesigned nose) has BMW 801 engines; K--bomber has BMW 801's, and M--bomber has DB 603 A engines. E-5 carrying HS-293 glider bomb was used against Allied convoys. N--night-fighter version of M subtype with heavier armament (may include 2-4 oblique guns).

Description: Twin-engine, shoulder wing monoplane. All-metal stressed skin. Wing tapers moderately to rounded tips. Cockpit is forward of leading edge. Twin fins and rudders. Fins are slotted for single engine control. Landing gear retracts rearward. Jettisonable umbrella-shaped dive-brake was once used for the tail; wing dive-brakes may be used.

Dimensions(ft): Span: 62' 5" Length: 56' 6" Wing area (sq ft): 610

Weights(lbs): Normal take-off: 32,000 Maximum: 34,000

Power plant: 2 BMW 801 A/2, 14-cylinder, twin-row, air-cooled fan-assisted radial.

Armament/Bomb Load: 1 x 7.9 mm flexible nose (1,000 rounds)
1 x 13 mm dorsal turret (500 rounds)
1 x 13 mm ventral (1,000 rounds)
2 x 7.9 mm side (750 rounds each)

Performance: Max speed: 290 mph at S.L. 330 mph at 22,000 ft
Service ceiling: 27,000 ft.
Range: 1,170 miles at 210 mph (with normal load)
1,165 miles at 240 mph (with normal load)
2,400 miles (with maximum fuel)

Remarks: Used as a bomber, and dive bomber, also for torpedo-dropping, mine laying or towing gliders. Cannot be considered to have been a success in any operational field.

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DO-335 A Duties: Fighter/fighter-bomber.
DO-635*

Development: The unusual tandem-engine layout was patented by Dornier in 1937; permission to build the prototype was not given until 1942. Available in small numbers at the end of the war, it was never encountered on operations.

Sub-types: A-0, day fighter and fighter bomber. A-1, day-fighter and fighter bomber. A-6, night-fighter. A-10, 11, 12 two-seater trainers. B-series patterned after the A series, modified and equipped specifically for use as a heavy fighter and night fighter.

Description: Twin-engine, low-wing monoplane. The engines drive propellers at opposite extremities of the fuselage. Tail unit is of cruciform shape with fin and rudder continued below fuselage. Retractable tricycle undercarriage.

Dimensions(ft): Span: 45.3' Length: 45.5' Wing area (sq ft): 414

Weights(lbs): Normal take-off: 21,160 Maximum: (A-6) 22,230

Power plant: Two DB 603 E's in tandem in the fuselage, the nose driving a conventional tractor propeller and the rear engine, positioned behind the pilot, driving a pusher propeller at the tail through a long hollow shaft.

Armament/Bomb Load: Day fighter 3 x MK-103 2 x MG-151/20: night fighter 1 x MK-103 2 x MG-151/20 (all fixed firing forward) Maximum bomb load 500 kg.

Performance: Max speed: 477 mph at 21,000 ft.
Service ceiling: 37,000 - 40,000 ft.
Rate of climb: To 26,000 ft in 13 mins.
Range: 868 miles at 428 mph at 23,000 ft.
1,280 miles at 295 mph at 19,700 ft (at economical cruising speed)

Remarks: Dr. Dornier built and flew at least eight different types of tandem propellered aircraft in the last twenty years. His latest, the DO-335, has been described as a little difficult to fly with a tendency to porpoise. Its performance is nevertheless outstanding.

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*DO-635
Two DO-335's spliced together by a common wing center-section. Each fuselage and tailplane is complete in itself. Aircraft has four engines and propellers (two tractor, two pusher), and a four-wheeled landing gear (two nose wheels, two main wheels). Probably envisaged as a long-range

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bomber-reconnaissance aircraft; had never flown.

Span 90 ft, wing area 866 sq ft.
Maximum speed 450 mph at 21,300 ft (with MW-50).
Maximum range 4,720 miles at 21,300 ft.

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FI-156 — Duties: Staff transport: short-range reconnaissance.

Development: An original design developed specifically for slow-speed flight and landing and taking-off from short, restricted and unprepared airstrips. One of the GAF's principal army cooperation aircraft.

Sub-types: 0-1, staff transport; 0-2, short-range reconnaissance; F-, can be fitted with external carriers for light bombs. All C's are tropical versions.

Description: Single-engined high-wing monoplane. Metal, fabric covering. Wing is parallel in chord, braced by "V" struts. Adjustable metal slot fitted along wide leading edge. Fuselage is rectangular. There is a braced tail, single fin and rudder. Landing gear is fixed and exceptionally strong to permit heavy landings.

Dimensions(ft): Span: 46.7 Length: 32.5 Wing area (sq ft): 280

Weights(lbs): Normal take-off: 2,920

Power plant: Argus AS-10C/3, 8-cylinder, air-cooled, inverted "V".

Armament/Bomb Load: Free dorsal - 1 x 7.9 mm

Performance: Max speed: 110 mph at S.L.
Service ceiling: 16,700 ft
Rate of climb: To 6,500 in 9 min.
Range: 240 miles at 60 mph (at S.L. with crew of 3)
630 miles at 60 mph (at S.L. with crew of 1)

Remarks: Stalling speed 34 mph, landing speed 25 mph with run of under 100 ft.

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FW(TA)-152 [redacted] UNCLASSIFIED

Development: TA-152 C was the first series productional and operational subtype of the modified FW-190. The "long-nosed FW-190" was redesignated the TA-152 by its designer when he altered the nose to give a smoother fuselage topline and installed hydraulic operation for the flaps and undercarriage.

Sub-types: TA 152 A (almost identical with the FW-190 D) had a Jumo 213 A engine but did not go into production; the TA 152 B with a Jumo 213 E was never produced in large quantity. C subtype with DB-603 L, TA-152 E used for recce, and TA 152 H (with pressurized cabin) for high altitute recce (48' 6" wing span). Only C, E and H subtypes were intended as standard equipment.

Description: Single-engined, low-wing cantilever monoplane. Wing structure modified to carry extra fuel tanks thus raising internal fuel capacity to 231 gallons (also 32 gallons of MW-50 can be carried).

Dimensions(ft): Span: 36.1 Wing area (sq ft): 216.

Power plant: All subtypes have a liquid-cooled engine. The B, E and H have a Jumo-213 E, the C a DB-603 L.

Armament/Bomb Load: Heavy armament fitted-combination of 20 mm and 30 mm forward firing guns.

Performance: Max speed: C-subtype: 467 mph at 35,000 ft (using MW-50): H-subtype: 465 mph at 30,000 ft (with MW-50); 472 mph at 41,000 ft (with GM-1)

Remarks: H series is a long-span version for high-altitude operation and is fitted with pressurized cabin.

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FW(TA)-154 Duties: Night and bad-weather fighter

Development: Designed to meet a specification for a short range night-fighter and bad weather day fighter with a high maximum speed and an endurance of 2 3/4 hours. Rapid development and quantity production were emphasized, together with extensive use of material not in short supply, especially wood.

Sub-types: A-1 two-seater day fighter, A-2 single-seater day fighter, A-3 two-seater night fighter. B series (with metal nose) never produced. C-1 two-seater night fighter, C-2 single-seater day fighter, C-3 two-seater day fighter.

Description: Twin-engined, high-wing monoplane. One piece shoulder wing of wooden construction with straight leading edge, and swept forward trailing edge. Nacelles project beyond trailing edge. Constructed of wood, the fuselage is in one piece from front bulkhead to the axis of rotation of the rudder with armor protection for the pilot and wireless operator in cockpit forward of leading edge. The cantilever tailplane is of light metal. Tricycle undercarriage.

Dimensions (ft): Span: 52.5 Length: 41.3 Wing area (sq ft): 349

Weights(lbs): Normal take-off: 18,600 Maximum: A-2 (with GM-1) 19,480

Power plant: Two Jumo 211N or 211R engines. Annular radiators.

Armament/Bomb Load: 2 x MK-108 and 2 x MG-151/20 fixed forward fuselage.
(4 x MK-108 or 4 x MG-151/20 are alternatives)
2 x MK-108 oblique guns may be installed in fuselage.

Performance (FW-154 A): Max speed: 382 mph at 19,000 ft (with Jumo-211 N)
394 mph at 26,300 ft (with Jumo-211 R)
Service ceiling: 31,200 ft. (with Jumo-211 N);
35,800 ft. (with Jumo-211 R)
Rate of climb: To 26,200 ft in 16 mins (Jumo-211 N),
in 14$\frac{1}{2}$mins (Jumo-211 R)
Range: (Jumo-211 N) 1,195 miles at 23,000 ft (with 2 X 66 gal drop tanks)
(Jumo-211 R) 1,160 miles at 23,000 ft

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Remarks: Outstanding differences between A and C sub-types are the installation in the C of two Jumo 213 A engines, a metal nose, and, in night-fighter two oblique, upward-fighter MK-108 guns. In the day fighter version of the C subtype, provision is made for 6 x MK-108 (fuselage mounted). The emergency maximum speed of the C-3, using GM01, is 428 mph at 32,800 ft.

The TA-154 never became operational; it is reported that lack of a suitable adhesive for its wooden construction led to many difficulties, including a number of fatal crashes on test-flights.

The TA-254 was intended as a high-altitude modification; it differed from the TA-154 in that an increased wing span provided increased wing area. A and B subtypes of the TA-254 have been identified.

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FW-190 Duties: Fighter/ground-attack.

Development: First version, with BMW-139 14-cylinder radial, flew in 1938. Engine then replaced by BMW-801 and several airframe structural modifications incorporated. Intended ultimately to fit liquid-cooled in-line engine. Became operational in 1941--used extensively thereafter. Performance substantially increased by fitting of power-boosting systems, heavier armament mounted as improved guns became available.

Sub-types: A-1: 4 x 7.9 mm and 2 x MG-151/20
A-3/R-6: 4 x MG-151/20, 2 x MG-131
Other A subtypes with variations of armament.
B subtype: airframe differing in detail only.
D subtype: DB-603 or Jumo-213 liquid-cooled engine -- only became operational in the final stages of the war. The "long-nosed" FW-190.

Description: Single-engine, low-wing cantilever monoplane. Wings have moderate taper, blunt tips with rounded corners. Metal stressed-skin construction. Single fin and rudder. Wide-track undercarriage.

Dimensions(ft): Span: 34.5 Length: 29.5 Wing area (sq ft): 197

Weights(lbs): Normal take-off, 8,600 Maximum: 10,350

Power plant: BMW-801 D, 14-cylinder, two-row, air-cooled (fan assisted) radial

Armament/Bomb load: 2 x 7.9 (or 13) mm fixed forward fuselage
2 (or 4) x 20 mm fixed wing
550 lbs (normal), 1,100 lbs (max)

Performance: Max speed: 402 mph at 18,000 ft. (408 mph at 20,600 ft with MW-50)
(With BMW-801 engine)
Service ceiling: 34,000 ft.
Rate of climb: To 33,000 ft in 26½ mins
Range: 950 miles at 298 mph

Remarks: Special bomber version carried one 3500 lb bomb.
The D-9 subtype, with a DB-603 or Jumo-213 liquid-cooled engine and MW-50 boost attained a maximum speed of 440 mph at 15,600 ft. A later subtype, the D-12, with MW-50 boost applied to the Jumo-213 engine, gives 453 mph at 37,000 ft. Provision is made for a 30 mm cannon firing through the propeller boss. D-subtypes have fuselage of increased length (33.9 ft).

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FW-200 **Duties:** Bomber/recce.

Development: A militarised version of the FW-200 "Condor" transport, first produced in 1940. The C series then became a standard long-range reconnaissance bomber.

Sub-types: C-1 and C-2 had BMW-132 engines; subsequent C-series subtypes had BMW-323's.

Description: Four-engined low-wing monoplane of all-metal mixed stressed-skin and fabric construction. Bomb bay in form of extended bola below fuselage has gun positions fore and aft. Single fin and rudder. Retractable undercarriage. Crew of eight.

Dimensions(ft): Span: 107.6 Length: 78.2 Wing area(sq ft): 1,270

Weights(lbs): Normal take-off, 50,000

Power plant: BMW-132, or 323 9-cylinder radials.

Armament/Bomb Load: Dorsal: 1 x 15/20 mm (forward hydraulic turret, 1 x 13 mm. (manual aft turret)
Lateral: 2 (or 4) x 7.9 mm (or 2 x 13 mm).
Ventral: 1 x 15/20 mm (forward), 1 x 7.9/13 mm (aft) in bola.
Bomb load: 3,600 lbs (normal); 10,800 lbs (maximum)

Performance: Max speed: 2.7 mph at S.L.: 240 mph at 13,000 ft.
Service ceiling: 20,500 ft.
Rate of climb: To 16,000 ft in 25.5 mins
Range: 2,150 miles at 165 mph (with 3,600 lbs bombs)
2,700 miles at 165 mph (max fuel, no bombs).

Remarks: Bomb stowage, additional to under-fuselage bomb bay, is provided by external carriers under outboard engine nacelles and outboard of those nacelles. Torpedoes, if carried, were slung from those outboard wing carriers. Provision made for carrying two HS-293's, one from each outboard wing carrier.

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GO-242(GO-244) Duti... UNCLASSIFIED

Development: This twin-boom transport glider was designed ... to the ultimate installation of engines, the powered version being the GO-244. In extensive use from 1942 on.

Sub-types: A and B subtypes differed only in detail.

Description: High braced wing, twin boom monoplane of wood, fabric, plywood and metal tubing construction. Has a central nacelle, hinged in the rear for loading purposes. Flaps and lift spoilers are fitted to the wings. Jettisonable wheeled landing gear is provided for the glider version, landing being effected on three skids; the powered version has a simple, robust, fixed tricycle undercarriage. Typical tug was the JU 52, HE 111, or ME 110.

Dimensions(ft): Span: 79' Length: 52.6 Wing area (sq ft): 700

Weights(lbs): Normal take-off, 17,500

Power plant (GO-244): Two Gnome-Rhone 14M, 14-cylinder, twin row air-cooled radials installed in nacelles forming the extension of the twin booms.

Armament/Bomb Load: Free f'rd fuselage 1/2 x 7.9-mm Free dorsal 1 x 7.9-mm Free tail 1 x 7.9-mm. Typical stowage - 840 cu. ft. Freight 5,300 lb.

Performance (GO-244): Max speed: 169 mph at 10,000 ft
Cruising speed: 100 mph at S.L.
Rate of climb: To 10,000 in 21 min.
Range: 375 miles at SL

Remarks: Crew of two carried in forward section of fuselage, which is well glazed.

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HE-177 Duties: Bomber/recce/torpedo-
*HE-277 dropping and glider-bomb attacks.

Development: Produced in 1942 after four years of development. Production abandoned in October 1944 after some 200 aircraft had gone into service. Trouble with the coupled engines led to development of the B-subtype with four separate engines; this subtype did not progress beyond the prototype stage.

Sub-types: A-1 (bomber) subtypes had 2 x DB-606 "double engines" composed of two DB-601 E engines geared together. Subtypes from A-3 were powered by 2 x DB 610 (each of two DB-605's). A-7 DB-613 engines and increased wing span.

Description: Twin-engine, mid-wing monoplane. Metal stressed-skin construction. Technically four-engined, it appears as twin-engined. Highly-developed Fowler flap arrangement designed to cover greater part of trailing edge. Fuselage is of rectangular section, about one-third of length forward of leading edge. Single fin and rudder angular-shaped.

Dimensions(ft): Span 103.5 Length: 72.0 Wing area (sq ft): 1,076

Weights(lbs): Normal take-off, 68,000 Maximum: 73,500

Power plant: DB 610 ("Twin" DB-605), 24-cylinder, liquid-cooled, inverted twin "V".

Armament/Bomb Load: All free: Forward fuselage 1 x 7.9 mm; Dorsal: forward turret 1/2 x 13 mm, rear turret 1/2 x 13 mm; Tail: 1 x MG 151/20; Gondola: 1 x MG 151/20 (forward), 1 x 13 mm (rear); Observer's position: 1 x 7.9 mm. Typical bomb-loads are: 48 x 70 kg, or 10 x 500 kg, or 6 x 1,000 kg, or 2 x 2500 kg, or 2 x HS-293 glider bombs.

Performance: Max speed: 250 mph at S.L.; 300 mph at 20,000 ft.
Service ceiling: 26,500 ft.
Rate of climb: To 17,000 ft in 25 min.
Range: 1,150 miles at 210 mph (Normal fuel / bomb load)
3,000 miles at 210 mph (Max fuel, no bombs)

Remarks: Used for anti-convoy and U-boat cooperation duties. Subtype A-3 and A-5 used in night attacks against England in January 1944. Never

*HE-277: An improvement on the HE-177 had four separate DB 603 engines and a cruising range of 5,000-6,250 miles.

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very successful in its operational use and introduced into combat in limited quantity only. Almost ceased to operate after an ineffective and weak effort against the Normandy invasion.

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HE-219 Duties: Night fighter

Development: Designed in 1940/41 as a high performance fighter it came into service as a night fighter during 1944/1945.

Sub-types: Representative subtypes are A-2 with 2 x DB-603A engines, A-5 and A-7 with DB-603's. The HE-219 B, a long-span version with Jumo-222's, did not go into service.

Description: Twin-engined mid-wing monoplane of all metal construction. Fuselage is long and slim with nose projecting forward of engines. Long engine nacelles extend beyond trailing edge. Twin fins and rudders. Tricycle landing gear, fully retractable. A turbo-jet unit may be fitted optionally under central bola.

Dimensions(ft): Span: 60.7 Length: 51.0 Wing area (sq ft): 480/500

Weights(lbs): Normal take-off: 26,000 Maximum: 29,900

Power plant: Two DB 603 12-cylinder, liquid-cooled inverted "V" engines.

Armament/Bomb Load: 4 x MG 151/20 (300 rds per gun) in detachable fairing under fuselage; provision for two additional forward firing guns in wing-roots. 2 x MK-108, oblique upward-firing, behind cockpit.

Performance: Max speed: 325 mph at S.L.: 400 mph at 22,000 ft.
Service ceiling: 32,800 ft.
Range: 1545 miles (with max fuel load)
960 miles at max continuous speed.

Remarks: It is said a rocket projector tube can be mounted under each wing outboard of nacelles. GM-1 power boosting equipment may be fitted. Comprehensive radar installation was fitted to night-fighter.

Crew of two (or three) provided with full armor-plating.

Heralded as the answer to the Mosquito, the HE-219 did not live up to its pre-operational publicity.

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HS-129 **Duties:** Dive bomber/ground attack

Development: Designed primarily for ground-attack operations. First used operationally as counterpart of Russian "Stormovik" (IL-2) in 1942, now obsolescent. Developed for close cooperation of GAF with Army. Noted for heavy armor and armament.

Sub-types: A subtype, the original version, was fitted with AS-410 inverted "V" air-cooled engines; B subtype was fitted with French-built Gnome-Rhone 14 M 04/05 air-cooled 14-cylinder radials. B-1 and B-2 are the most common subtypes.

Description: Twin-engined single-seater low-wing monoplane. Wings are tapered, tips slightly rounded. Fuselage of triangular section; nose drops away sharply forward of cockpit. Metal, stressed skin, flush-riveting. Single fin and tall rudder. Landing gear retracts into nacelles, a portion of wheel remaining visible.

Dimensions(ft): Span: 44.5 Length: 33.3 Wing area (sq ft): 305

Weights(lbs): Normal take-off: 11,400

Power plant: 2 Gnome-Rhone 14M 04/05, 14-cylinder, twin-row, air-cooled radials.

Armament/Bomb Load: All fixed firing forward: forward fuselage 2 x 7.9 mm / 2 x 15/20 mm. One 30 mm gun (or 4 x 7.9 mm) forward firing under fuselage as alternative to the 770 lb bomb load.

Performance: Max speed: 240 mph at S.L.: 275 mph at 9,000.
Service ceiling: 24,500 ft. (with max. load)
Rate of climb: To 10,000 ft in 7 min.
Range: 440 miles at 150 mph.
350 miles at 216 mph.

Remarks: Some B-2 subtypes were experimentally equipped for antitank work with a battery of six 75 mm smooth-bore recoilless guns, fitted in the fuselage to fire downwards and rearwards.

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HS-130 Duties: High-altitude bomber/ reconnaissance

Development: Developed during 1943 as a high-altitude bomber and reconnaissance aircraft, but not used operationally.

Sub-types: A - two DB-605 engines and no armament: C - two BMW-801 D turbo-supercharged engines. E- 2 x DB-603 and 1 x DB-605 (see below)

Description: Twin-engined, mid-wing monoplane with pressurized cabin. All metal, stressed skin construction. Circular section fuselage with cabin forming forwafd part. Cantilever tail unit, single fin and rudder. Single-leg undercarriage, retracts hydraulically into nacelles; retractable tail wheel.

Dimensions(ft): Span: 108' Length: 64.7'

Weights (lbs): Normal take-off, 38,000

Power plant: 2 x DB-603 S or T + 1 x DB 605 T; the latter is fitted in the fuselage and drives a Roots blower for supply of air to superchargers of the DB-603's.

Armament/Bomb Load: 2 x MG 131 in turrets, one above and one below cabin rotating through 360°; 1 x MG 151/20 in tail turret. All remotely controlled and with periscopic sights.

Performance: Max speed: 320 mph at 10,000 ft.
Service ceiling: 45-50,000 ft.

Remarks: In efforts to secure a propeller suitable for the power at altitude, blade widths of 17.7 ins were used; to reduce weight to a minimum, the propellers were made of pine or balsa wood by the Schwartz process, or of light-alloy.

Special electrical equipment was required for high-altitude operations.

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JU-88 A   Duties: Bomber/recce/torpedo-bomber

Development: First flown as a bomber in 1936 and approximately 50 had been built by the beginning of 1939. Basic design was subsequently adapted for a wide variety of duties and JU-88 aircraft in various forms were in operation and production when hostilities ceased.

Sub-types: 17 subtypes in the A-series were produced, powered by various subtypes of the Jumo-211; several of those subtypes were trainer types.

Description: Twin-engined low-wing monoplane. Wing center section slightly "gulled". Top and bottom of fuselage are flat, sides curved. Nose and cockpit of angular, faceted type. Single fin and rudder. Slotted dive brakes are fitted under wings. Landing gear retracts rearward into nacelles, wheels turning through 90°. All metal, stressed skin construction.

Dimensions(ft): Span: 65.9 Length: 47.0 Wing area (sq ft): 590

Weights(lbs): Normal take-off: 28,400 Maximum: 31,800.

Power plant: Two Jumo-211 J, 12-cylinder, liquid-cooled, inverted "V".

Armament/Bomb Load: Flexible nose: 1 x 7.9 mm. Dorsal: 1 x 7.9 mm / 1 x 13 mm. Ventral: 1 x twin 7.9 mm. Bomb load: up to 6,600 lbs.

Performance: Max Speed: 242 mph at S.L.; 291 mph at 14,000 ft.
Service ceiling: 27,000 ft.
Rate of climb: To 16,500 in 21.4 min.
Range: 1,310 miles at 193 mph] with normal
1,230 miles at 254 mph] fuel and bomb load

Remarks: Data supplied is for A-4 and applies basically to subtypes A-1 to A-14.

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JU-290 Duties: Bomber-Glider towing
Transport

Development: Developed from the JU-90 and intended to supersede the FW-200 for long-range, over-water, anti-shipping and U-boat cooperation work. Originally designed for transport work and first test flown in 1941.

Sub-types: A-1, transport; A-3 and A-5 recce; A-6 transport; A-8, recce (With provision for carrying two HS-293).
B subtype was a projected heavily armed long-range bomber version, with a strengthened fuselage and modified nose design.
C (transport-recce), D (long range bomber) and E (projected night-bomber) subtypes also identified.

Description: Four-engined low-wing monoplane. Metal stressed skin construction. Fuselage is of square section with rounded corners. Pilot's cockpit well forward in nose. Twin fins and rudders at extremities of horizontal stabilizer. Landing gear has double wheels and retracts hydraulically rearward into inboard nacelles.

Dimensions(ft): Span: 138 Length: 92.9 Wing area (sq ft): 2,210

Weights(lbs): Normal take-off: 90,000 Maximum: 100,000

Power plant: Four BMW-801 L-2, 14-cylinder, twin-row, air-cooled, radial.

Armament/Bomb Load: Varies according to duty. Nose-heavily armed reconnaissance version carries 2 x 20 mm (dorsal front), 2 x 20 mm (dorsal rear), 1 x 20 mm (tail), 1 x 20 mm (ventral forward), 1 x 13 mm (ventral rear), 2 x 20 mm (lateral) and 1 x 20 mm (nose).

Performance: Max speed: 209 mph at S.L.; 280 mph at 18,000 ft.
Service ceiling: 19,000 ft.
Rate of climb: To 18,000 in 43.5 min.
Range: 1030 miles at 191 mph) With normal
990 miles at 203 mph) fuel/bomb load
2490 miles with 17,600 lbs of freight.

Remarks: Transport version carries up to 48 passengers or 22,000 lbs of freight. Underneath of fuselage constitutes hinged ramp to facilitate loading.

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JU-388   Duties: Fighter

Development: The JU-388 was the latest of the JU-88 series to reach the production stage. First test flown in 1943, it was included in the restricted production program which was in force when hostilities ended. Developed basically from the JU-188, many features of which are retained, and of which it is essentially a pressurized version.

Sub-types: JU-388 K bomber version has large bomb bulge similar to that on the JU-88 S and JU-188 S. Only armament is rear turret - twin MG 131. JU 388 L recce aircraft similar to K, bomb bulge omitted. J subtypes are night fighter versions, with heavy armament.

Description: Twin-engined, low-wing monoplane. All subtypes have provision for pressurized cabin. Basic appearance is same as the JU-188, except for remotely-controlled tail turret. On the long-range versions, the fuselage beneath the bomb-bay has a "bath-tub" effect.

Dimensions(ft): Wing area (sq ft): 602

Weights(lbs): Normal take-off, 30,000 to 30,700 Maximum: 32,350

Power plant: 2 x BMW 801 TJ or 2 x Jumo 213 F (turbo-super charged).

Armament/Bomb Load: Night fighter: Bola 2 x MG 151/20 + 2 x MK-108; oblique 2 x MG 151; rear turret-twin MG 131 (remote-control). Bomber and recce: Twin MG 131 in remote-control rear turret. Provision for both internal and external bomb stowage.

Performance: Max speed: 272-285 mph at S.L.: 389-407 mph at 30,000 ft. (with MW-50).
Service ceiling: 40,000 ft.
Rate of climb: 1545 ft/min at S.L.; to 30,000 ft in 27.5 mins
Range: 1400-1600 miles at 36,000 ft (no drop tanks)
1700-2000 miles at 36,000 ft (with drop tanks).

Remarks: Crew of 3 (4 in night-fighter) well protected by armor-plate. The L subtypes were intended for photo reconnaissance. Jumo - 222 A/B engines were planned as alternative power units. A special periscopic sight-was fitted for use with the remote-control tail turret.

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JU-390 Duties: Transport/bomber/long-range recce

Development: A six-engined development of the JU-290 with increased span and overall length. An extra panel mounting a BMW 801 E engine introduced in each wing. New fuselage centre section increased length. Test flown in 1943.

Sub-types: Data herein given is for transport version. Long-range recce type has six built-in fuselage tanks. Armament identical with JU 290 C (recce). Long-range bomber version has four build-in fuselage tanks and equipment for HS-293 operations is added.

Description: Six-engined, low-wing monoplane.

Dimensions(ft): Span: 165 Wing area (sq ft): 2,728

Weights(lbs): Normal take-off, 161,000

Power plant: 6 x BMW-801 E 14-cylinder, twin-row, air-cooled radial.

Armament/Bomb Load: Twin 20 mm in forward dorsal, aft dorsal, tail, ventral and nose positions

Performance: Max speed: 260 mph at 18,700 ft.
Rate of climb: At S.L. (Wt. 161,000 lbs) 690 ft per min.
Range: 4,970 miles at 205 mph at 6,500 ft (7,500 gals fuel)
4,040 miles at 217 mph at 6,500 ft (6,000 " ")

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JU-488 D[illegible]

Development: With the object of developing a four-engined bomber with a minimum of disturbance to existing design and production arrangements, the Germans experimented with fitting four engines to basic JU-88, JU-188 and JU-288 designs. None of the developments exceded prototype stage.

Description: Four-engined low-wing monoplane. New inboard wing sections each mounting one extra engine. Nose similar to JU-188. Fuselage lengthened by adding new sections. Tail unit similar to JU-288 with twin fins and rudders.

Dimensions(ft): Span: 100 Length: 66.7

Power plant: Four BMW 801 engines 14-cylinder, air-cooled radial.

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ME 109 E   Duties: Fighter/bomber/ground-attack

Development: ME 109 E developed from original ME 109 which appeared 1936-1937. Used as standard single seat fighter until end of 1940, when it was superseded by the F and G types. Final main role as advanced trainer.

Description: Single-engined, low-wing monoplane. Automatic slots and slotted flaps are fitted. Adjustable strut-braced stabilizer. Balanced rudder and elevator. Fixed tail wheel. Landing gear retracts outwardly (hydraulically).

Dimensions(ft): Span: 32.5 Length: 29.0 Wing area (sq ft): 175

Weights(lbs): Normal take-off, 5,850 Maximum: 6,500

Power plant: DB 601 A, 12-cylinder, liquid-cooled inverted "V". GM-1 may be installed.

Armament/Bomb Load: 2 x 7.9 mm fixed forward fuselage
2 x 20-mm fixed forward wings
4 x 50 kg typical bomb stowage; alternative 1 x 250 kg.

Performance: Max speed: 300 mph at S.L. : 355 mph at 18,000 ft.
Service ceiling: 35,000 ft.
Rate of climb: To 16,500 in 6.2 min.
Range: 655 miles at 200 mph (with normal fuel and
450 miles at 300 mph (bomb load

Remarks: Germany originally intended to concentrate on a single type of fighter but neither the DB 601 nor the BMW 801 engine could be produced in sufficient quantities. Lack of a satisfactory engine delayed the development of a new fighter aircraft and the ME 109 airframes underwent continual modifications. These changes without alteration to the fundamental design interfered with mounting additional armament and reduced endurance of the aircraft. Alterations became a series of progressive deteriorations in aerodynamics.

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ME-109 G Duties: Fighter/ground attack/ recce

Development: Developed from ME 109F. Appeared in service in September 1942, very extensively used until Germany's capitulation.

Sub-types: G-1, G-3 and G-5 have pressurizing equipment for sustained operation at high altitudes; port wing carries oxygen bottles. G-2, has no pressure cabin or G-1; G-6, has plywood tail. G-10, fastest subtype (S.L. 344 mph). G-14 plywood tail unit.

Description: Single-engined, low cantilever wing. All-metal monocoque fuselage. Rounded triangular section. Made in two halves. Cantilever monoplane tail; usual tail unit has metal covering on fixed surfaces, fabric on movable surfaces. Semi-retractable tail wheel.

Dimensions(ft): Span: 32.7 Length: 29.9 Wing area (sq ft): 172

Weights(lbs): Normal take-off: 6,820 Maximum: 7,230

Power plant: DB 605 A/1 12-cylinder liquid-cooled inverted "V"

Armament/Bomb Load: Fixed forward fuselage 2 x 7.9/13 mm
Fixed forward wings 2 x 20-mm (fitted in fairings under wings)
1 x 20/30 mm through propeller hub. 2 x 21 cm rockets under wing.

Performance: Max speed: 330 mph at S.L.: 380 mph at 30,000 ft; 400 mph at 22,000 ft.
Service ceiling: 39,500 ft.
Rate of climb: To 19,000 in 6 min.
Range: 615 miles at 200 mph (with normal fuel)
450 miles at 330 mph (" " ")
795 miles at 310 mph (with maximum fuel).

Remarks: When wing guns are fitted, maximum speeds are reduced by about 25 mph, service ceiling by 1,000 ft. Fitting of MW-50 increases emergency speed by about 40 mph. Two cameras sometimes fitted in rear fuselage. Late sub-types incorporated greater use of wood and plywood as substitutes for metal.

Typical bomb stowage: 1 x 550 lbs, or 4 x 110 lbs; maximum 1 x 1100 lbs. External stowage below fuselage.

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ME-209 Duties: Fighter

Development: Developed from the ME-109; overall construction showed greater limitations in connection with its employment than the ME-109. Series production was rejected and it was never used operationally.

Description: Single-engined low-wing monoplane with inward retracting undercarriage.

Dimensions(ft): Span: 36.0 Wing area (sq ft): 182

Weights(lbs): Normal take-off: 8,200

Power plant: DB 603 with two-stage super charger.

Armament/Bomb Load: 2 x 20 mm (or 30 mm) fuselage (all fixed forward
2 x 20 mm and 2 x 30 mm wing (firing

Performance: Max speed: 453 mph at 28,000 ft.
Service ceiling: 38,700 ft.
Rate of climb: 2,150 ft/min at S.L.; 1,770 ft/min at 26,000 ft.

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ME-210 Duties: Bomber/fighter/ground-attack/reconnaissance

Development: Appeared in service in 1942; was eventually replaced by the ME-410.

Sub-types: A and B subtypes had DB-601 F engines; C subtype powered by DB-605's.

Description: Twin-engined, low-wing monoplane. Metal, stressed skin construction. Wings have pronounced taper to rounded tips. Nose is blunt. Fuselage slim with humped cockpit inclosure at forward end, finishing approximately over the trailing edge. Single fin and rudder is large. Landing gear retracts into nacelles.

Dimensions(ft): Span: 53.6 Length: 40.3 Wing area (sq ft): 400

Weights(lbs): Normal take-off: 21,600 Maximum: 24,500

Power plant: 2 x DB-605 (or DB-601) 12-cylinder, liquid-cooled, inverted "V" engines.

Armament/Bomb Load: 2 x 20 mm, 2 x 7.9 mm fixed forward fuselage
2 x 13 mm lateral in remote control "blister" barbettes.
Bomb load: 1100 lbs (normal); 2400 lbs (maximum).
Various alternative stowages.

Performance: Max speed: 315 mph at S.L.; 370 mph at 21,000 ft.
Service ceiling: 29,000 ft. (with normal load); 35,000 ft. (minimum fuel, no bombs).
Rate of climb: To 19,000 ft. in 11.8 mins
Range: 1350 miles at 240 mph (with normal load of
1180 miles at 315 mph (fuel and bombs.
2120 miles at 300 mph (with maximum fuel and no bombs).

Remarks: The ME-210 C was the most widely used of the ME-210 subtypes. It was superseded largely by the improved ME-410. The rearward firing 13 mm guns in "blister" barbettes on the sides of the fuselage slightly aft of the wing are electrically remotely controlled from the rear cockpit.

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ME-264 Duties: Bomber/long-range recce

Development: Designed to supplement the JU-290 and HE-177. HE-177 was unsatisfactory and this design was pushed by Messerschmitt for heavy bombing and long-range reconnaissance. A few expermental models constructed - never operational. Prototype first flown in December 42.

Description: Four-engined monoplane; wing of exceptionally high aspect ratio. A tricycle undercarriage is fitted and each main oleo leg has a supplementary sheet for take-off with full load which is jettisoned, then undercarriage is retracted. Turrets and window guns.

Dimensions(ft): Span: 141 Wing area (sq ft): 1375

Weights(lbs): Normal take-off: 107,800 Maximum: 123,200

Power plant: Four Jumo-211 engines; BMW-801's, DB-603's or Jumo-213's ultimately were to be fitted.

Armament/Bomb Load: 1 x 13 mm (nose)
1 x 13 mm (dorsal forward)
1 x 20 mm (dorsal aft)
1 x 20 mm (ventral)
2 x 13 mm (lateral)

Performance: Max speed: 358 mph at 21,000 ft. (without GM-1); 372 mph at 27,200 ft (with GM-1)
Service ceiling: 26,200 ft.
Rate of climb: 350-630 ft. per min at S.L.
Range: 9,300 miles (without bomb load)

Remarks: Originally designed for bombing the American homeland from bases in Germany. One of Messerschmitt's most promising designs. Two supplementary BMW 003 or Jumo-004 turbo-jet units were to be fitted for bursts of high speed; with those units estimated maximum speed was 407 mph at 22,000 ft.

A six-engined version, projected but never built, had an estimated range of about 11,500 miles.

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ME 309 Duties: Fighter

Development: This aircraft was developed as a result of development of the DB 603 engine, but it did not advance beyond the experimental stage.

Description: Resembles the ME-109 F but fuselage is larger; reported as faster and more maneuverable. Retractable tricycle undercarriage, pressure cabin, and catapult seat.

Power plant: DB 603 12-cylinder, liquid-cooled inverted "V"

Armament/Bomb Load:	1 x MK 108/30 mm cannon	fixed firing forward.
	4 x MG-151/20 mm cannon	

Remarks: Did not give satisfactory performance, since DB-603 developed only 1500 h.p., not 2000 h.p. as expected. The ME-309 was abandoned when development of the ME-262 showed signs of success.

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ME 323 Duties: Transport

Development: Developed from the ME-321 towed glider.

Sub-types: D-1 and D-6 have variable-pitch metal propellers; D-2 has wooden fixed pitch propellers.

Description: Six-engined, high-wing monoplane. Powered version of the ME-321 glider. Wing has pronounced taper to blunt ends, entire center section has a plywood skin with fabric covering. Fuselage of steel tube framework with fabric covering; tail unit arranged to pivot and provide variation of tail plane incidence. Undercarriage comprises ten wheels, and is designed to overcome ground obstacles like a caterpillar tractor.

Dimensions(ft): Span: 180 Length: 94.1 Wing area (sq ft): 3225

Weights(lbs): Normal take-off: 99,000 maximum: 122,000

Power plant: Six Gnome-Rhone 14-N 48/49 14-cylinder air-cooled radials.

Armament/Bomb Load: Free forward fuselage: 2 x 7.9 mm upper, 2 x 7.9 mm lower. Free dorsal: 4 x 7.9 mm forward, 2 x 7.9 mm rear, 6 x 7.9 mm lateral. 2 x 7.9 mm. ventral aft.
Freight: 26,900 lbs (normal), 44,800 lbs (max); 60-100 troops

Performance: Max speed: 163 mph at S.L.; 194 mph at 13,000 ft.
Service ceiling: 23,000 ft.
Rate of climb: 710 ft/min at S.L.
Range: 720 miles at 129 mph) with normal fuel and
640 miles at 163 mph) 26,900 lbs freight.
140 miles at 139 mph with maximum freight.

Remarks: Two flight engineers, who control engines, are carried in cabins entered through cat-walks in wing; only flight controls in pilots cockpit. Not all the 18 available gun positions are used at once. Provision for rocket-assisted take off. Main loading space (about 2,000 cu. ft.) is capable of holding a 3-ton truck or light tank. Secondary loading space of 1,410 cu. ft. Guns of 13 mm caliber may replace the 7.9 mm guns.

ME-410 Duties: Bomber/fighter/recce.

Development: ME-410 is a re-engined ME-210, the airframes are similar.

Sub-types: A-1 fast bomber; A-1/U2 heavy fighter conversion; A-3 reconnaissance aircraft with increased range.

Description: Twin-engined, low-wing monoplane. Metal stressed skin construction. Wings have pronounced taper to rounded tips. Nose is blunt. Fuselage slim with humped cockpit enclosure at forward end. Behind this the fuselage is of small cross section. The single fin and rudder is large. Dive brakes of extruded alloy strips are fixed on upper and lower wing surfaces.

Dimensions(ft): Span: 53.6 Length: 40.9 Wing area (sq ft): 400

Weights(lbs): Normal take-off: 24,000 Maximum: 26,000

Power plant: 2 DB-603 A-2 12-cylinder liquid-cooled inverted "V".

Armament/Bomb Load: Bomber version: Fixed forward fuselage 2 x 7.9 mm and 2 x 20 mm
Lateral 2 x 13 mm in remote-controlled barbettes.
Bomb load 1,100 lbs (normal), 2200 lbs (Maximum).

Fighter version has additional 2 x 20 mm or 1 x 50 mm in bomb bay.

Performance: Max speed: 330 mph at S.L.; 395 mph at 22,000 ft.
Service ceiling: 30,000 ft. (normal load); 39,000 ft (minimum fuel, no bombs).
Rate of climb: To 19,000 ft. in 11.5 min.
Range: 1,190 miles at 255 mph with normal load
1,040 miles at 330 mph
2,130 miles at 250 mph with maximum fuel and no bombs.

Remarks: Flat transparent panel in nose for dive bombing attacks, although I.A.S. in a dive restricted to 310 mph at 22,000 ft., 403 mph at 10,000 ft.

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TAB F

DATA ON INTERNAL COMBUSTION AIRCRAFT ENGINES

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AS-411

Type: 12-cylinder inverted-vee 60° air-cooled. Single-speed supercharger. Geared propeller drive.

Description: Valves have steel barrels, aluminum alloy heads; bore 105 mm, stroke 115 mm., capacity 12 liters. Argus-Hobson carburettor. Single lever fuel control with automatic altitude and boost control. 87 octane fuel. Bosch hand/electric starting. Clockwise propeller drive.

Supercharger: Single impeller with gear ratio of 8.73:1. Spring drive.

Dimensions (ins): Width: 28.0 Length: 64.8

Weight: 847 lbs.

Performance: T.O. and
Emergency: 590 hp at 3,300 rpm at 1.8 ata at S.L.
Climbing: 495 hp at 3,250 rpm at 1.45 ata at 8,000 ft.
Max cruising: 390 hp at 3,100 rpm at 1.35 ata at 8,500 ft.
Fuel consumption: 0.463 lb/hp/hr. max-cruising, S.L.

Note: 1 Ata = 14.7 lbs/sq. in. = 760 mm (30 in.) mercury.

BMW-801

Type: 14-cylinder air-cooled radial. Cooling fan fitted. Propeller reduction gear. Two-speed supercharger.

Description: Bosch electric starting system. Cylinder bore 156 mm. Stroke 156 mm. Capacity 41.8 litres; compression ration6.5:1. Valves of each bank operated by a cam ring front and rear of engine, and push rods. Master rods in cylinders 8 (rear row) and 9 (front row). Direct injection pump. Four-stage pressure pump and two-stage scavenge pump for lubrication. "Kommandogerat", master control box, controls boost pressure, r.p.m., mixture strength and supercharger change-over height.

Supercharger: Centrifugal impeller with two-speed gear. Drive ratio 5.07:1, 7.46:1.

Dimensions (ins): Width: A-52.3 C-48.4 Length: 80.2

Weight: A: 2669 lbs. B: 2702 lbs. C: 2321 lbs.

Performance: T.O. and

Emergency:	1600 hp at 2700 rpm at 1.32 ata at S.L. ft.
Climbing:	1310 hp at 2400 rpm at 1.25 ata at 14,500 ft.
Max cruising:	1170 hp at 2300 rpm at 1.15 ata at 15,000 ft.

Fuel consumption: 0.506 lb/hp./hour max. cruising, S.L.

Remarks: Main difference between the BMW 801-A,-B,-C and -L is in the type of propeller control, except that the B-subtype has left-handed rotation. Complete power "eggs" of these engines are designated MA, MB and ML: the BMW 801 C is only supplied as a bare engine.

Developed from the Bramo-329 and BMW-132, the BMW-801 was the first operational example of engines designed to develop 1600-2000 hp. Development was delayed, and after fitting to the DO-217 and FW-190, continuous major modifications had to be carried out in order to achieve the necessary reliability.

Later subtypes of the BMW-801--the D,G,Q,E,F,S and R--used higher octane fuel (96 octane against 87 octane), and improved compression ratio and supercharger design.

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BMW-803

Type: 28-cylinder, liquid-cooled, radial; contra-rotating four-bladed propellers.

Description: Has the appearance of two 14-cylinder radials joined together. Cylinders of each unit built in seven blocks of two, disposed radially around the crankcase. Cylinder blocks of the two units are in line. Superchargers and all auxiliaries driven from rear of engine. The two engine units are placed "back-to-back". Front unit drives front propeller through an extended shaft; rear unit drives rear propeller through a series of auxiliary shafts passing between cylinder skirts of front blocks.

Supercharger: Two-stage, four-speed.

Dimensions (ins): Width 64.0

Weight. 6,400 lbs; complete power plant 9,086 lbs.

Performance: T.O. and
Emergency: 3,960 hp at 2,950 rpm at 1.5 ata at S.L.
Climbing: 3,240 hp at 2,600 rpm at 1.3 ata at 17,700 ft.
Max cruising: 2,800 hp at 2,400 rpm at 1.2 ata at 18,000 ft.
Fuel consumption: 0.54 lb/hp/hr: climbing at S.L.

Remarks: Never progressed beyond the experimental stage in Germany.

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DB-601

Type: 12-cylinder, water-cooled, 60° inverted-vee.

Description: Cylinder bore 150 mm., stroke 160 mm., capacity 33.9 liters. Big-end and main bearings are roller and lead bronze respectively. Fuel (92-octane) injected into each cylinder by a 12-cylinder in line Bosch pump proveded with automatic mixture control. Starting by hand or electrically energized inertia starter. Bosch magneto fires two Bosch plugs per cylinder.

Supercharger: Single stage gear-driven centrifugal type.

Dimensions (ins): Width 30.0 Length 68.5

Weight: 1,400 lbs (dry weight).

Performance: T.O. and

Emergency:	1,395	hp at	S.L.
Climbing:	1,395	hp at	14,000 ft.
Max cruising:	1,220	hp at	15,000 ft.

Remarks: Obsolete.

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DB 603 A,B,C,D.

Type: 12-cylinder inverted "V" 60°, liquid-cooled. In general a scaled-up version of the DB 605.

Description: Cylinder bore 162 mm. Stroke 180 mm. Capacity 44.5 litres. Compression ratio 7.5:1 (left block) 7.3:1 (right block). Each block has a single camshaft operating the respective valves through rocker arms. Bosch direct injection pump is located between the cylinder blocks. Plain spur gear propeller type drive embodying pitch-change mechanism for VDM propeller.

Supercharger: Centrifugal type driven through a hydraulic coupling.

Dimensions (ins): Width 33.2 Length 104.4 (including prop.shaft).

Weight: 2000 lbs.

Performance: T.O. and
Emergency: 1,750 hp at 2,700 rpm at 1.4 ata at S.L.
Climbing: 1,510 hp at 2,500 rpm at 1.3 ata at 18,700 ft.
Max cruising: 1,400 hp at 2,300 rpm at 1.2 ata at 17,700 ft.
Fuel consumption: .474 lb./h.p./hour, max cruising, S.L.

Remarks: The DB-603, after teething troubles had been overcome, proved to be a reliable engine. Although available in 1943, no suitable airframe was designed for it.

A variety of additional DB-603 subtypes subsequently were produced; these varied in supercharger design, power-boosting equipment, etc. The DB-603 E, similar to the A, but with a larger supercharger, developed 1,800 hp for take-off, 1,430 hp. at 23,150 ft in the climb, and 1,325 hp. at 22,000 ft. maximum cruising.

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DB 605

Type: 12-cylinder, inverted "V" 60° liquid-cooled.

Description: Very similar in basic construction to the obsolete DB-601. The main improvements are an increase in the permissible r.p.m., altered valve timing, complete re-design of the cylinder block to obtain maximum possible bore with existing cylinder centers, and re-positioning of sparking plugs.

Supercharger: Centrifugal impeller with 16 blades. Hydraulic coupling drive automatically regulated by a control capsule subjected to atmospheric pressure. Ratio (no/slip) 10.07:1.

Dimensions (ins): Width 30.4 Length 86.3

Weight: 1683 lbs.

Performance: T.O. and

Emergency:	1,475 hp at 2,800 rpm at 1.42 ata at S.L.
Climbing:	1,250 hp at 2,600 rpm at 1.3 ata at 19,000 ft.
Max cruising:	1,080 hp at 2,300 rpm at 1.15 ata at 18,000 ft.
Fuel consumption:	.473 lb./h.p./hour max. cruising, S.L.

Remarks: Only went into series production after a long development period; still was not up to standard at the end of the war. The main weakness lay in the fact that oil was fed to the main bearings from the outside, and not through the crankshaft. The cylinder head was re-designed, with chromium-plated valves and a modified spark plug arrangement; by this means it was possible considerably to increase the thermal load.

The DB-605 AS -- an A subtype fitted with a DB-603 supercharger-- brought the rated altitude up to 27,600 ft. The fitting of MW-50 improved low-altitude performance, while GM-1 was introduced to improve performance at high-altitude.

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DB-606

Type: 24-cylinder liquid-cooled, of two DB-601's mounted side by side with a common reduction gear and extended propeller shaft.

Description: The superchargers are mounted on the outer side of each engine. One engine has right-handed rotation, the other left-handed rotation.

Dimensions (ins): Width: 65.2 Length: 83.3

Weight: 3,330 lbs

Performance: T.O. and

Emergency:	2,700 hp at 2,700 rpm at 1.42 ata at S.L.
Climbing:	2,400 hp at 2,500 rpm at 1.3 ata at 16,000 ft.
Max cruising:	2,080 hp at 2,300 rpm at 1.15 ata at 16,700 ft.

Fuel consumption: 600 liters/hour/max. cruising, S.L.

Remarks: Provision is made for declutching the individual engines from the propeller drive by means of a clutch and lever in the cockpit.

Abandoned quickly, as the DB-601 had gone out of series production. Difficulties experienced with bearings and a proclivity to catch fire whenever the engine was damaged.

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Jumo-205

Type: 6-cylinder, opposed-piston, Diesel two-stroke. Two crankshafts, cylinders vertical. Liquid-cooled.

Description: Cylinders have steel barrels and are pressed into main crankcase casting. Upper piston controls the exhaust ports, lower piston controls the inlet ports. Light alloy pistons. Two six-throw crankshafts, upper and lower. Gear driven scavenging blower, mounted at rear of engine.

Dimensions (ins): Width 24.0 Length 77.7

Weight: 1144 lbs.

Performance: T.O. and
Emergency: 600-700 hp
Max cruising: 510-590 hp
Fuel consumption: 0.374 lb/hp/hr., max. cruising.

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Jumo-207 C
*207 D

<u>Type</u>: Six-cylinder compression ignition liquid-cooled engine. Two stroke cycle. Opposed pistons. Upper and lower crankshafts.

<u>Description</u>: Two centrifugal superchargers in series, the first being driven by an exhaust turbine. After cooler fitted between engine driven supercharger and induction galleries. Diesel oil fuel is sprayed into each cylinder by means of four nozzles. Cylinders 105 mm. bore. Connecting rods 'H'- section with double row. Propeller drive right-hand rotation. Four gear-type lubrication pumps driven from lower crankshaft. Big-end and main bearings have steel shells.

<u>Supercharger</u>: Engine driven centrifugal supercharger mounted beneath turbine driven unit. Double shrouded impeller has radial vanes and aluminium alloy entry guide vanes. Gear ratio 8:1.

. Exhaust driventurbine consists of nozzle ring, turbine rotor and outlet volute. Twin waste gates, by-passing the rotor, are used to control the effective mass flow of exhaust gas.

<u>Dimensions</u> (ins): Width 36.4 Length 87.0

<u>Weight</u>: 1,903 lbs (without propeller)

<u>Performance</u>: T.O. and
Emergency: 1000 hp at 3,000 rpm at S.L.
Climbing: 750 hp at 2,700 rpm at 30,000-40,000 ft.
Max cruising: 680 hp at 2,700 rpm at 30,000-40,000 ft.
Fuel consumption: .374 lb/hp/hour, max. cruising 40,000 ft.

<u>Remarks</u>: Basically a Jumo-205 with a turbo-blower, the Jumo-207 was used to power the JU-86 P high-altitude reconnaissance aircraft. With GM-1 boost, a maximum altitude of 49,000 ft. was achieved (45,500 ft. without GM-1).

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*The bore of the D series is increased by 5 mm. Develops 1,200 h.p. for take off.

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Jumo 211

Type: 12-cylinder inverted "V" 60^{0}, liquid-cooled. Two-speed supercharger and propeller reduction gear.

Description: Cylinder bore 150 mm. Capacity 34.97 litres. Compression ratio 6.5:1. Valve gear operated by single camshafts through rockers. Crankshaft of unusual design for an aero-engine, the webs being in the form of flat plates and extended to form balance weights. All bearings are lubricated through holes drilled in journals and crankpins. Lead bronze in steel shells is used for main crankshaft bearings. Aluminium alloy pistons. Junkers direct injection fuel pump.

Supercharger: Two speed centrifugal supercharger, ratio 7.85:1 and 11.37:1 Impeller is of the 'spout' type and diffuser is without vanes.

Dimensions (ins): Width 32.1 Length 70,0

Weight: 1,408 lbs

Performance: T.O. and

Emergency:	1,200 hp at 2,400 rpm at 1.35 ata at S.L.
Climbing:	930 hp at 2,300 rpm at 1.15 ata at 16,500 ft.
Max cruising:	810 hp at 2,100 rpm at 1.10 ata at 14,700 ft.
Fuel consumption:	0.462 lb/hp/hour, max. cruising, S.L.

Remarks: A standard bomber engine in the early days of the war. The constant demand for increase in bomber payload called, in turn, for an increase in the power output of the Jumo-211. At the end of its development, the F and J subtypes had a take-off rating of 1,350-1,450 hp, using 87-octane fuel. All the J series were fitted with an inter-cooler, which increased performance by about 40%; at high speed, that increase was nullified by the resistance of the inter-cooler. Nevertheless, the improvement in the rate of climb of the JU-88 to more than 6.5 ft./sec. was very marked.

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Jumo 213

Type: 12-cylinder, inverted "V" 60°, pressure cooled. Two-speed supercharger and propeller reduction gear.

Description: Cylinder bore 150 mm. Valve gear, single camshaft driven by bevel gears. Dished pistons. Junkers direct-injection fuel pump. Master control box, mounted at rear of the engine, amplifies cockpit lever motion into control of boost pressure, supercharger inlet vanes, fuel injection pump, magneto advance, propeller pitch and slow running cut-off throttle.

Supercharger: Ratio 6.857:1 and 9.378:1. 12-bladed DVL fully shrouded impeller of 270 mm. diameter. 15 diffuser ring blades. Fan inlet casing and forms a variable air inlet. These blades are movable about their axes, the movement being automatically controlled.

Dimensions (ins): Width: 31.0 Length: 97.5

Weight: 1,984 lbs.

Performance: T.O. and
Emergency: 1,776 hp at 3,250 rpm at S.L.
Climbing: 1,480 hp at 3,000 rpm at 18,000 ft.
Max cruising: 1,220 hp at 2,700 rpm at 17,000 ft.
Fuel consumption: 463 lb./h.p./hour, max. cruising S.L.

Remarks: Performance data given above is for the A-subtype. Further development resulted in additional subtypes: C (with a hollow propeller shaft for an engine mounted gun), E (fitted with a three-speed, two-stage supercharger and induction cooler), F (Similar to the E, but with MW-50 injected before third stage of the three-stage supercharger), J (with increased r.p.m. and three-speed supercharger) and T (turbo-supercharged). The E developed 1,320 hp at 32,500 ft., the F 1,800 hp at 17,700 ft., and the T 1,600 h.p. at 38,000 ft. The E-subtype (2,000 h.p. for take-off and a rated altitude of 32,500 ft.) was fitted to the TA-152; it showed a considerable advance, as it showed similar good qualities to the well-tried Jumo-211, was of simple construction and had the new servo-mechanism.

Jumo 222

Type: 24-cylinders in six blocks of four equally disposed radially around the crankcase. Epicyclic reduction gears. Two-speed supercharger.

Description: Cylinder bore 135 mm. Stroke 135 mm. Capacity 46.5 litres. Compression ratio [illegible].5:1. Fuel injector mounted between the two inlet valves. Four throw flat crankshaft. Split master connecting rod and five articulating rods. Valve gear has single camshafts in nine split bearings. Three separate injection pumps. Each pump feeds two blocks of cylinders. Three delivery trunks from supercharger volute casing.

Supercharger: Driven by plain spur gears from rear of crankshaft. Rectangular air intakes with "eyelid" throttles lead the air through variable-pitch guide vanes into the eye of the supercharger. A master control box is mounted above the air intakes.

Dimensions (ins): Width: 46.4 Length: 98.8

Weight: 2,420 lbs.

Performance:

T.O. and Emergency:	2,500 hp at 3,200 rpm at S.L.
Climbing:	2,090 hp at 2,900 rpm at 16,400 ft.
Max cruising:	1,700 hp at 2,700 rpm at 17,000 ft.
Fuel consumption:	.447 lb./hp/hour, max cruising, S.L.

Remarks: The above performance data are for the A and B (Series 1) subtypes. Series 2 and 3 of the A and B subtypes had increased capacity, modified ignition system, giving increased output at altitude. The C and D subtypes, with increased r.p.m., had take-off power of 3,000 hp. The E and F subtypes, fitted with an after-cooler, had a rated altitude of over 30,000 ft. A turbo-supercharged version--the G and H subtypes--was projected.

Intended for the JU-288 and for further development of the HE-177, development of the Jumo-222 was delayed, particularly by connecting rod troubles, and eventually, when it became evident that the problems could not be overcome in time, the engine was cancelled from the production list.

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Jumo 223

Type: 24-cylinder Diesel type.

Description: Designed as a high-power Diesel engine of low specific weight. Comprises four Jumo two-strike Diesels in "box" form with four crankshafts. Capacity 29 liters.

Dimensions (ins): Width: 49.6 Length: 102.4

Weight: 5,214 lbs (complete power plant)

Performance: T.O. and
Emergency: 2,500 hp at S.L.
2,500 hp at 20,000 ft.
Fuel consumption: .385 lb./hp/hour, max cruising, S.L.

Remarks: Several experimental models, without a turbo-supercharger fitted, were produced and later abandoned in favor of Jumo 224.

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Power Boosting Systems

Methanol-Water (MW-50):

Fluid: MW-50 fluid consists of 49.5 parts (by volume) of tap water, 0.5 parts of anti-corrosion fluid and 50 parts of Menthanol.

Installation: On the ME-109, the mixture is carried in a cylindrical tank of 25 gallons capacity situated behind the pilot. Boost pressure from the supercharger is utilized to apply pressure to the tank, forcing the mixture along a pipe to an injection nozzle in the eye of the supercharger. The flow of mixture is controlled by a solenoid valve, actuated by an automatic throttle switch and a water switch in the supply pipe line.

Performance: The system is used to obtain extra power below the rated altitude of the engine. The mixture is injected into the intake side of the supercharger and acts as an anti-detonant, providing charge cooling and enabling higher boost pressures to be used. A 4% increase in power can be obtained even at constant boost pressure. The increased power can be used for a maximum of 10 minutes at a time; at least 5 minutes must elapse between successive periods of operation. At the increased power the spark plugs have a life of only 15 to 30 hours.

Below is a table showing the performance of the TA-152 B with, and without the MW 50 system.

Engine	Alt. (ft.)	Normal hp.	Inc. hp.	Normal Max Speed (mph)	Inc Max Speed (mph)
DB-603 L	S.L.	1800	2100	339	359
DB-603 L	29,600	1450	1750		
DB-603 E	S.L.	1800	2250	342	370
DB-603 E	18,000	1630	1900		

Nitrous oxide (GM-1):

Fluid: This power boosting system was first referred to by the Germans by the code-name "ha-ha" because nitrous oxide or "laughing gas" is injected into the supercharger. The nitrous oxide is retained under pressure in liquid form.

Installation: In the JU-88, liquid was carried in three cylindrical containers locked in the fuselage. Later aircraft had a single container. Compressed air cylinders contain air used for forcing the liquid along pipe lines.

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to the engines. At the normal injection rate of 7.95 lb/engine/minute, endurance is 45 minutes.

Performance: Designed for use above the rated altitude of the engine, this system provides additional oxygen for the engine and acts as an anti-detonant.

Performance of aircraft, with and without the GM-1 system, is shown below.

A/C	Normal Max. Speed	With Fre-quency GM 1	GM 1 Endurance Normal	Emergency
ME 109 G (DB 605)	430 at 25,000	450 at 30,000	24 min	14.5 min
FW 190 A (BMW 801)	415 at 22,000	430 at 26,000		

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TAB G

DATA ON AIRCRAFT ARMAMENT

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Aircraft Armament

Designation	Caliber (mm)	Length (ins)	Weight (lbs)	Rate of fire (r.p.m.)	Muzzle velocity (ft/sec)	Remarks
MG 15	7.9	42.4	15.75	1,000	2,675	Designed by Rheinmetall; hand-held for bomber defense.
MG 81	7.9	35	13.88	1,200-1,500	2,675	Designed by Mauser; hand-held for bomber defense.
MG 81Z						Twin combination of MG 81's used for bomber defense.
MG 131	13	46	40	700	2,370	Designed by Rheinmetall. Used as a fixed gun in fighters, in free hand-held positions in bombers, and in power-operated turrets.
MG 151/15	15	75 1/3	84.1	650-750	2,900	Designed by Mauser. Superseded by MG 151/20.
MG 151/20	20	69 5/8	93.5	550-750 (synchronised) 750-800 (unsynchronised)	2,500	Standard Mauser 20 mm. gun for general use.
MG FF	20	52 3/4	60	350	1,950	Short-Oerlikon. Used as fixed gun in fighters, hand-held gun in bombers.

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Aircraft Armament

Designation	Caliber (mm)	Length (ins)	Weight (lbs)	Rate of fire (r.p.m.)	Muzzle velocity (ft/sec)	Remarks
MK 103	30	90	321	Approx. 400	Approx. 2,700	Designed by Rheinmetall. This is the latest high-velocity 30 mm. gun to go into service.
MK 108	30	41½	134	600	1,700	Designed by Rheinmetall. This is a low-velocity, high-capacity weapon widely used in fighters at the end of the war.
Flak 18	37	142⅓	590		2,690	A converted A.A. gun. Used on the JU 87 D for ground attack.
BK 5	50	171			Approx. 2,000	A converted anti-tank gun mounted in some ME-410's.

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Aircraft Armament

Italian Guns-Ansaldo

Designation	Caliber (mm)	Length (ins)	Weight (lbs)	Rate of fire (r.p.m.)	Muzzle velocity (ft/sec)	Remarks
47/32 A/TK	47	59.2	582	7-8	2060	Normal use: antitank and infantry close support.
102/35 AA/CD	102	140.7	Not known	8	2950	Normal tactical use: anti aircraft.
152/45	152	269.1	18.5 tons	2-3	2730	

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R4M aircraft rocket:

This rocket was developed for air-to-air use from fighter aircraft, particularly the FU 190, ME-262 and ME-163. The enemy planned to use it against heavy Allied bombers in conjunction with the EZ 42 gyro-gunsight. It is not certain whether this rocket was ever used operationally, but it was in full production. It represents one of the latest examples of aircraft rocket design and deserves special attention since it was intended to be used on the newest jet fighters.

An unrotated, rail or tube launched, single venture, solid fuel propelled, multi tail fin stabilised missile, the R4M is designed for air-to-air employment. The warhead has an exceptionally thin case and high charge weight/case weight ration. It is motion-armed and impact-fused.

Overall length	31.75 ins.
Diameter	2.12 ins.
Warhead length	10.2 ins.
Total weight	7.62 lb.

No details are available on the performance of the rocket or the warhead filling and propellant.

The warhead consists of a sheet steel case 1 mm. thick in two pressed steel sections welded together and enclosing the H.E. charge. The base of the warhead case is crimped on to a brass end-piece threaded to a screw in the motor. The motor is a drawn steel tube of 2 m/m thickness formed

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at the tail into a venturi of 4.75" length, throat diameter of 0.5" and outlet diameter 1.0". Spot welded to the venturi is the stabilising fin support of cylindrical sheet steel. At the centre of gravity of the missile a single spring loaded suspension bracket is spot welded to the motor. The propellant charge consists of a single grain of tubular cordite (14.75" x 1.75") with a concentric hole (0.5"). Igniter leads run through wood sealing plug in the venturi, to the igniter which is in the foreard end of the motor tube.

Stabilisation is achieved by eight hinged and spring loaded fins folded forward flush against the motor for storage and erected by air spoilers when the missile is launched.

Rail type and tube type launchers were developed; neither type has been recovered for examination.

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Bomb-Torpedo.

Designed principally for use by fighters in attacking shipping. the bomb-torpedo also is suitable for action against land targets. Considerable numbers were manufactured, but it is believed none were used operationally.

There are four sizes of the weapon, BT-200 (440 lbs), BT-400 (880 lbs), BT-700 (1,540 lbs), and BT 1400 (3,080 lbs). Charge/weight ratio of the BT 200, BT 400, and BT 700 is 50%; for the BT 1400 it is 72%.

A long truncated cone and a cylinder form the body, the tail unit tapers to the rear and carries three fins (to stabilize flight of the bomb). At the extreme nose a non-ricochet plate is attached. The whole design is intended to enable the bomb to enter the water on a flat trajectory and continue under water without deviation of course at as great a speed, and for as great a distance, as possible. Experiments showed no ricochet when the angle of impact was kept above 3^{0} and a straight under-water course was maintained.

The three smaller bombs have fusings circuits, one instant (as bomb hits ship) the other delay, (0.12 or 0.18 seconds after bomb enters water).

Some BT-1400's were to be fitted with a magnetic proximity-operated pistol having an approach sensitivity of 26 ft.

The three-finned tail unit is arranged to separate from the bomb on impact with water. In the smaller sizes this occurs through breakage at a

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weak point; with the BT-1400 it is brought about by a detonator.

For anti-shipping attack the FW 190, DO 335, ME 262, ME 410 or AR 234 all were to be used as parent aircraft. To allow of shallow-angle attack, the TSA-2 bombsight was specially developed.

With this bomb very low level attack on reilroads, roads and other land targets was possible. Even with a 10° angle of impact the bomb does not ricochet.

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BV-246 Glider Bomb:

This radio-controlled glider bomb consists basically of a warhead estimated to contain 900-1,000 lbs of amatol, on which the wings are mounted in the shoulder position. The wings, of very high aspect ratio, are of laminated steel plate construction covered with a cement filler to give a smooth aerofoil section. The tail unit, of wooden construction, is faired into the warhead by a plywood cone; it carries twin elevators and twin fins, but only one rudder, this being on the port fin. On the top of each fin is a container for a flare.

It is known that a similar type of glider bomb has been fitted with a homing device fitted to an extension of the nose. The controls are believed to have been fitted in the lower half of the tail cone.

Principal dimensions of the BV-246 are 21.1 ft span, 11.0 ft. length.

As a radio-controlled glider bomb, the BV-246 presumably could have been carried by, and air-launched from, a medium bomber. There is evidence that the Germans planned to use a modified version, without radio-control equipment, with the FW-190 as parent aircraft.

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Panzerschfeck and Panzerblitz:

Adopted for aircraft use from land armament models, these projectors were designed for low-level operations against armored vehicles (and were reported as able to penetrate up to 12 cm. of armor plate).

Panzerschfeck: In the Panzerschreck three 88 mm rocket projectiles were carried in projectors of German open-tube type held in a frame work of three semi-cylindrical containers which were fitted into an ordinary ETC bombrack under each wing of an FW-190. It was superseded by the lighter Panzerblits unit.

Panzerblitz: The Panzerblitz projector was stated to have the same merits as the Panzerschreck and providded the additional advantage of enabling an FW-190 to carry six rockets under each wing.

Each apparatus consisted of six rockets held in a framework of six metal rails, familarly called the "garden fence". The frame is secured to the wing structure by four bolts and cannot be jettisoned.

Hollow charge 80 mm. rocket-projectiles are used. This non-rotating projectile consists of a permanently linked high-explosive head and rocket motor. Six sticks of cordite form the charge and are fitted in the nose of the projectile with an impact fuse.

The Rocket motor (weight-9.68 lbs) consists of a tubular steel body (12.76" long and 3.15" in external diameter), a propellant charge, a grid, a finned steel venturi, and an electric igniter system.

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"Natter" BP-20 - Target defense interceptor

Development: The Natter was designed as a rocket-propelled, short-range, home defense interceptor to protect vital targets against mass bomber attack. Dr. Walter of Kiel stated aircraft of this type were the only answer to the problem because they could be launched in any weather. Operation is midway between an interceptor fighter and a directed missile. Up to the cessation of hostilities, several prototypes had been built and, at least one flown.

Description: Single-engine, mid-wing monoplane, cruciform tail. Fuselage is of semi-monocoque construction with laminated wood skin; made in two sections, the joint is forced apart when the pilot is ejected. Fuel tanks (for T & C-Staff) are located immediately behind pilot's rear bulkhead. Wooden wing is fixed and has wood spar. Tailplane large by comparison with wing but of similar construction. Two fins and rudders are fitted one above, one below fuselage.

Dimensions(ft): Span: 13.1 Length: 20.6 Wing area (sq ft): 51.6

Weights(lbs): Normal take-off: 4925

Power plant: HWK 109-509 bi-fuel rocket unit (109-559 alternate) assisted take off rockets: 4 solid fuel (500 kg or 1000 kg).

Armament/Bomb Load: 33 R4M rockets, 2 x MK-108 guns

Performance: Max speed: 620 mph at 16,400 ft.
Rate of climb: 37,400 ft/min.
Range: 36 miles at 500 mph at 9,800 ft.
Endurance: 4.36 minutes at 500 mph at 9,800 ft.

Remarks: Take off ramp inclined at an angle to the direct vertical. Originally the aircraft was completely expendable with a pilot ejecting device; later a parachute was built in the fuselage for returning the rear section (containing the power-unit) to earth. The pilot would be ejected automatically before impact if a ramming attack were made.

The ramp was to be pointed at the bomber formation and the A.T.O. rockets fired; the acceleration being such that the pilot would black out, the BP-20 was fitted with an automatic pilot to operate until the pilot regained consciousness.

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TAB H

DATA ON ELECTRONICS EQUIPMENT

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Data on Electronic Equipment

Radar - Ground and Shipborne:

(Note: Certain German radar equipment is applicable either to shore or surface installations or even to airborne employment with minor modification)

Würzburg D:	AA fire or searchlight control radar. Original spread of radio frequency: 550/580 Mc. Maximum spread: 475/600 Mc. PRF: 3,750 cps. Pulse length: 1.5 to 2 microseconds. Power output: 7 to 11 kw This is the most widely used German gun laying radar.
Würzburg C:	Early model of Würzburg D.
Würzburg A:	Early model of Würzburg D.
Würzburg Riese: (Giant Würzburg):	Essentially a Würzburg D with a larger antenna parabola (7.4 meter diameter compared with 3.1 meters)
Dachs:	Code word for Filter screen apparatus for Würzburg
Eidechse:	Code word for transmitter, condenser and oscillator for Würzburg
Emil:	Code word for distance indicator for Würzburg
Igel:	Code word for impulse generator for Würzburg
Katze:	Code word for filter screen apparatus for Würzburg
Saturn:	Code name for height and direction locator on Würzburg
Zobel:	Intermediate frequency amplifier for Würzburg

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Freya: Standard early warning radar.
Radio frequency (nominal): 115 to 145 Mc.
PRF: 550 cps.
Pulse length: 2 to 5 microseconds.
Power output: 15 to 20 kws.

Dreh Freya: Fighter control

Fahrstuhl Freya: Modification of Freya Gerate 42.
Horizontally polarized dipole pairs separate for transmission and reception.
The Fahrstuhl is a height measuring procedure for determining altitude of aircraft. The antenna moves in the vertical plane providing height over 3.5° to 15°.

Freya LZ: Probably LZ Luft Ferlegbar: Broad band antenna built in small components for air transportation. Motor turns the entire mount at 8 rpm.

Mammut (Hoarding): Early warning radar.
Radio frequency: 187 to 220 Mc.
PRF: approximately 500 cps.

Seetakt (FuMO 1, FuMG 40 G): Coastal radar (target search and coastal supervision).
Radio frequency: 375 Mcs. (with Wismar 333 to 428; 250 to 333).

Hohentwiel: ASV radar.
Radio frequency: 555 Mcs. (adjustable over a band from 508 to 568 Mcs).
Employed by the Germans for aircraft, surface and U-boat installations.

Mannheim (FMG 41 T or FuSe 64): AA fire control radar.
Radio frequency: 560 Mcs.
PRF: 3750 ?
Pulse length: 1.5 microseconds.
Power output: 12-20 kws.

Athos: German radar intercept receiver.
Frequency: 9 to 3 cm. (3,333 Mc. to 10,000 Mc).

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Airborne Radar and IFF

Fug 200:	Refer Hohentwiel above
Fug 202 (Lichtenstein):	Air interception equipment. Frequency: 490 Mc. Installation: night fighters (BC 2 type employed the super receiver) Perception range: 2½ to 3½ km. Receiver not remote control
Fug 213 (Lichtenstein S):	ASV radar. Frequency: old - 4.1 meters new - 3.3 meters Range: 85 km at 5,500 meters altitude against medium ships.
Fug 216A (Neptun V):	Tail warning radar Frequency : 166 Mc.
Fug 224 Panorama (Berlin):	German equivalent of British H2S. Frequency: 3333.3 Mc. Navigational and line bombing aid One modification provedes panoramic search for night fighters. There are several modifications of this set in existence.
Fug 25:	Identification Friend or Foe. Radio frequency approximately 550 Mc receiver and 150/160 transmitter. Provides identification to Würzburg. Antenna streamlined rod 3/4 wave length 551 Mc. Vertically polarized. Obsolete; replaced by Fug 25A.
Fug 25A:	Identification Friend or Foe. Radio frequency. Receiver sweeps 123 to 128 Mc. (Transmitter covers band 150/160 Mc.) Units: transmitter receiver coding unit and power supply in one unit. Provides identification to early warning radar.
Fug 136:	Pulse repeater for Egon control. Frequency: 125 Mc. Component of Fug 25A.

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Radio altimeters, navigational aids and blind-bombing devices:

Fug 101 F gerate:	Radio altimeter low altitude. Frequency-334 to 400 Mc. Swept at speed of 80 cycles per second. Three units: transmitter, receiver and indicator. Operation: frequency modulated radio altimeter. Two ranges: 0 to 150 meters and 0 to 15,000 meters are provided but the installation was not so used operationally.
Fug 102 Pulse type:	Radio altimeter high altitude. Frequency: 181.8 mc (?) to 500 Mc. Operation: pulsed radio altimeter. Receiver and indicator in cockpit; transmitter and power supply in fuselage. Not in general use but may be found in large multi-enginee aircraft. Receiver: superheterodyne, 12 tubes. Antenna: mounted either inside fuselage with perspects panels or one to each wing. Two ranges: 0 to 5,000 meters and 0 to 10,000 meters.
Fug 103:	Radio altimeter high altitude. Frequency: 427 mc (?) to 500 Mc. Ranges: 0 to 5,000 meters and 0 to 10,000 meters.
Telefunken D/F EZ 4 EZ 6:	EZ 6 is the receiver for PeG VI homing receiver. EZ 4 - not identified.
PeG IV (Peilgerate):	DF receiver. Frequency: 0.25 to 0.4 Mc. Range: 150 miles approximate. Antenna: fixed loop 13" long, 3½" diameter. Used as a homing receiver prior to the introduction of Fug 16Z.

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PeG VI (Peilgerate VI):	DF receiver. Frequency: 0.15 to 1.2 Mc. Antenna: oval loop, metal paint on loop housing provides sense. May be used as a separate receiver in Fug 10 and is one of the few German sets using crystals.
Fug 320 (Schwan See):	Beacon buoy transmitter. Frequency: 40 or 45 Mc. Remarks: emergency sea transmitter. Jettisonable sea radio beacon buoy transmitter.
Y gerate (Benito):	Air navigation and bombing. Frequency: 40 Mc. System employs the Lorenz beam type of signal and permits range measurement. Different systems were employed by the Germans for bombers and fighters. Mobile control installations were also employed.
FuB 1 2F:	Blind landing equipment (Lorenz).
X gerate (Ruffian):	Blind bombing device. Frequency: 66.5 to 75 Mc. Signal visual dot-dash, left-right beams. Antenna: 2 vertical quarter-wave rods in streamlined housing. Special blind bombing device believed to be obsolete late in 1944.

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Communications Equipment:

Airborne Radio Sets

FuG 2: Believed to be obsolete

FuG 3a: Airborne radio
Frequency: 0.3 to 0.6 Mc.
Power output: 20 watts and 100 watts
Antenna: Fixed and trailing
Installed in: Bomber aircraft

FuG 7a: Airborne radio
Frequency: 2.5 - 3.75 Mc
Range: 15 miles for W and R/T
Power output: 20 watts
Antenna: Fixed in fighter aircraft; trailing in bombers
Was replaced by FuG 16F

FuG 10: Airborne radio
Frequency: .3 - .6 Mc
Range: 300-500 miles for C.W. and R/T
Power output: 40 watts (S.W.); 70 watts (L.W.)
Antenna: Both fixed and trailing

FuG 15: Airborne radio, "Christa"
Frequency: 37.8 - 47.8 Mc.
Common set operating on either FM or AM to replace FuG 16Z

FuG 16: Airborne radio
Frequency: 38-42.5 Mc.
Ranges: 20 miles at ground level; 100 miles in the air
Power output: 10 watts R/T
Antenna: Fixed wire 6' 11" long.
Installed in: All bombers for air-to-air and air-to-ground communication.

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<u>Jamming, Anti-Jamming and Countermeasures</u>

Wismar:	Anti-jamming procedure. Employed with Würzburg, Freya and Seetakt. Purpose: facilitates rapid shifting of the frequency of the radar set so as to escape electronic jamming.
Stendahl:	Anti-jamming device used on Würzburgs and Mannheims. Provides a means of tracking a formation by D/F ing on the airborne jamming transmitter.
Goldhammer:	Anti-jamming device used on Würzburg and Riese radar. Purpose: Provides a means of brightening up the main range and fire range scopes only when polarization of antennas is at right angles to the polarization of jamming signals.
Nürnberg:	Anti-jamming device used on Würzburg AA control radar. Purpose: Provides a means of aural reception of tone from propeller modulation to distinguish aircraft from Window.
Würzlaus:	Anti-jamming device. Used on Würzburg. Purpose: Provides a means of using the Doppler effect to distinguish between rapidly moving targets, e.g., aircraft; and stationary targets, e.g., Window or ground clutter.
Taunus:	Anti-jamming device fitted to all Würzburgs. Purpose: A short-time constant RC circuit discriminating against engergy reflected from Window and installed directly after the detection stage of the receiver.
Aphrodite:	U-boat deception device. Consists of a gas filled balloon and reflector dipoles released by U-boats when search receivers detect ASV radar signals.
Thetis:	Decoy target simulator. A radar decoy composed of corner reflector or metallic strips used by a submarine and designed to be put overboard when search receivers warn submarines of Allied ASV. Gives the same type of echo that a U-boat would give and lasts for 18 hours.

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Search receivers.

FuMB ant 3 (Rundipol): Broad band antenna for Wanze G-2 search receiver.

FuMB 9 (Wanze G 2): Search receiver.
Frequency: 166 to 250 Mc.
Installed in U-boats to detect code signals.
Modifications are Wanze 1 non-directional with CRT presentation, Wanze 2 non-radiating version of Wanze 1.

FuMB 10 (Borkum): Search receiver.
Frequency: 100 to 400 Mc.
Installed on U-boats to detect ASV radar signals.
Used in conjuction with a broad band antenna and low frequency amplifier for warning purposes.

FuMB 26 (Tunis): Search receiver.
Composition:
  (1) FuMB 24 (Fliege) 1500 to 3750 Mc.
  (2) FuMB 25 (Mucke) 1500 to 7500 Mc.
Installed on submarines for interception of 9 and 3 cm radar signals.

Fug 350 (FuMB 7 Naxos): Search receiver.
Several versions of this search set:
  (1) FuG 350Z
    Frequency: 2500 to 3750 Mc.
    Use: homing receiver for Rotterdam H_2S.
  (2) FuG 350Za
    Same as Naval Fu MB 7.
  (3) FuG 350Zb
    Frequency: 3000 Mcs.
    Use: homing on 10 cm radar.
  (4) FuG 350Zc: final airborne version.
  (5) FuG 350Zr:-unknown.
  (6) FuG 350Ax (Naxos ZX)
    Freq: 7500-12000 Mc
    Use: Homing on Meddo H_2X radar.

Sadir R 87 E and R 87 H: Not identified.

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Allied radar..

R 3002:	Receiver for British airborne IFF II.
BC 647A:	Receiver for SCR 535A. The American version of airborne IFF II- obsolete.
Meddo:	German code name for American H2X.
Rotterdam:	German code name for British H2S.
Berlin:	German modification of American H2S.
Rosendahl:	German code name for Monica.
Monica:	British backward-looking AI for bombers. Frequency 247.5 Mcs.

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Miscellaneous Electronic Equipment

Fug 217 (Neptun R II):	Airborne warning radar. Frequency: transmitter 1.8 meters plus or minus 4 cm. receiver 1.84 meters and 1.76 meters. Presentation crt picture giving range 2 to 10 km. Provides warning against night fighters.
Fug 218 (Neptun R III):	Airborne warning radar. Frequency: 1.6 to 1.9 (163 to 170 Mc.) Similar to Neptun II but contains the Wismar anti-jamming feature providing wide band of frequencies.
FuMG 404 (Jagdschloss):	Long range radar resembling a Wasserman on its side. Used for controlling night fighters in conjunction with Wasserman.
Wasserman (Chimney):	Long range search radar with height D/F Frequency: 125 Mc. Equipped with parabolic reflector and provides height D/F ing.
Wasserman M	Long range search radar with height D/F Wave lengths: 1.9 to 2.5 meters 1.2 to 1.9 meters 2.4 to 4.0 meters One of many modifications to Wasserman radar.
Adler Radio Telephone:	Radio telephone set used for communication between submarines to aircraft.
DMG 4K and 5K (Michael):	Decimeter communication equipment. Frequency: DMG 4K 500 to 560 Mc. DMG 5K 502 to 554 Mc. Operation: 2 channel voice or telegraph. Employed in link communication systems and as relay stations.
DMG 3G (Rudolph)	Decimeter communication equipment. Frequency: 600 to 552 Mc. Operation: 9 speech channels or 27 telegraph channels plus control voice channel.

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200 W AS 59:	Transmitter. Frequency: 2.5 to 20 Mc. Power: 200 watts Operation: CW MCW voice or teletype Operates with interceptor FuHEc which covers frequency used on line of communication links.
Powerline TAK 1107:	Rectifier set for 220 volts Used with 200 W AS 59.
Power set EM IV (FW 3,000 A):	Motor generator set. Two cylinder, 9 HP engine used with 200 W AS 59 and other sets. 220 volts AC, 13.6 amperes, 3,000 watts.
T 36 40:	Teletype machine. Operation: 110 or 220 volts AC. Used as tape teleprinter with international 5 unit code. Operates with German Commercial equipment but not British commercial equipment.
1.5 kw. Sender:	Communication transmitter. Frequency: 0.1 to 0.6 Mc. Power: 1.5 kw. Employed for communication GHQ to Army Groups and on main GAF nets. Receiver LWEa is used with this transmitter.
P 53 N:	Not identified
FuPMG:	Current tester. Otherwise not identified
Rehbock:	Artificial target testing device for Würzburg D. Provides target response at known ranges for the purpose of aiding in range calibration.
Ultra short wave communication set:	Not definitely identified but believed to be communication equipment intended for use in AFV's but not adopted as standard in Germany.

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Infra Red:

Adler I: Searchlight control equipment for use against aircraft. Average range, about 25 km; against receding bombers, ranges up to 35 km. Because of the small field of view (12 °) the equipment was unsatisfactory.

Adler II: Range approximately the same as Adler I. Field of view, however, was increased to 20°.

Evaporografie: Experimental IR detector using thin oil film in evacuated container for creating a screen for picture.

Flamingo: Revolving IR aircraft warning receiver for use on submarines. Range 7 km. against bomber. Equipment mounted outside boat in hemispherical glass dome. Inclined reflectives which can be rotated 25 times a second by an electric motor scans the sky above horizon through 360° and throws radiation on a Thallium Sulphide cell. The motor also generates voltages to produce a rotating time base on an indicating cathode ray tube inside the boat, and any sources of heat radiation at temperatures above 500° are shown as radial deflections from which bearing can be estimated to about 5°. "Flamingo" also fitted to surface ships and can be used as an all around viewing detector for an IR signalling system.

Gross Bildwandler: Equipment installed on small U-boats and airplanes in order to detect surface ships by the transmission of heat waves. Early models worked with a scanning disc similar to the discs employed on early television. The improved type had instead two vibrating reeds which scanned the area where detection was desired. This latter method proved rather successful. A cooled PbS cell was placed at the focal point of a parabolic receiver.

Kiel III: The FuG 380 (Kiel III) is essentially an airborne infrared aircraft intercept equipment for installation in German fighters for use against Allied bombers. Infra-red radiations given off by bomber aircraft are picked up by the equipment's scanning mechanism, which scans a conical pattern similar to that of certain types of American A.I. radar. The energy picked up is concentrated on a sensitive lead sulphide cell, and through the use of conventional amplifier

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and timing circuits, PPI presentation is obtained.

Diameter of I.R. scanning element	1.2°
Maximum diameter of cone of scan	30°
Estimated range from which reflections are obtained (interpolated from diagram)	Greater than 5.7 kms.

Linse: Small explosive boat directed to the target by an infra-red detection device.

Seehund III or Falter: Infra-red telescope used by night fighters for homing on to Allied infra-red recognition lamps.

Spanner II: Infra-red airborne receiver for locating aircraft by their exhausts. Average range, 12 to 15 km.; Focal length, 15 cm., 1:0.85; Field of view, 30°.

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TUBE NO.	TYPE	FREQ.	MFGR.	Mu	VOLTAGE	GERMAN TYPE SETS USING TUBE
EF 14	Pentode audio amplifier and detector			Variable		
LB 1	CRT (Small) 7 cm. diam. Electrostatic only		Telefunken		2000	FMG 39T (small Würzburg) FuG 200 Hohentwiel
LB 2	CRT (Small) Electro magnetic and electrostatic 7 cm. diam.				2000	
LB 9 N	CRT					
LD 1	Triode	UHF	Telefunken	11	300	FuG 200 Hohentwiel FuG 202 Lichtenstein FuG 212 Lichtenstein FuG 217 Neptun Target Beacon (Transmitter marker) DMG 4K and 5K (Decimeter radio set) FuG 25A (IFF) FMG 39T (Small Würzburg A)
[illegible]2	Triode	UHF	Telefunken	25	800	FuG 202 Lichtenstein FuG 212 Lichtenstein FuG 101 (Radio altimeter) Target Beacon FMG 39T A and C and Giant Würzburg
[illegible]5	Triode (single ended)		Telefunken			FMG 39T A and C and Giant Würzburg

TUBE NO.	TYPE	FREQ.	MFGR.	Mu	MAX. PLATE VOLTAGE	GERMAN TYPE SETS USING TUBE
LD 15	Triode	UHF	Telefunken			FuG 212 Lichtenstein
LD 20	Reflex klystron patterned after Raytheon 723A		Telefunken			
LG 1	Duo diode	UHF	Telefunken		100	FuG 200 Hohentwiel FuG 202 42G (Sub radar) DMG 4K and 5K FuG 217 Neptun FuG 25 (IFF) FMG 39T A,C and D and Giant Würzburg
LG 2	Duo diode	UHF up to 600 mc	Telefunken			KD 62 KD 64 FMG 39T
LG 10						
LFS 100	Magnetron	9 cm.				Berlin Gerate
LS 3	Diode triode	UHF	Telefunken	25	200	Transmitting tube
LS [redacted]	Triode	UHF	Telefunken	20	700	FMG 39T as a transmitting tube

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TUBE NO.	TYPE	FREQ.	MFGR.	Mu	MAX. PLATE VOLTAGE	GERMAN TYPE SETS USING TUBE
LS 50	Pentode	HF	Telefunken		1000	FuG 25A IFF T/C FuG 203 E FuG 11 FMG 39T Giant Würzburg and Small Würzburg A and C Sender B-400-VK-MR 39 (ground jammer) Naval radar KW/type In control transmitter for guided missiles
LS 66						
LS 180	Triode	UHF	Telefunken	15.6	1500	FMG 39T Giant Würzburg and Small Würzburg C,D,and A Breslau I & II Jammer
LV-1	Pentode					FMG 39T-All Würzburgs Sender B-400 (UK MR-39) FuG 200 Hohentwiel FuG 216 Neptun
MS 50/ 14R	Magnetron	40-60 cm.	Telefunken		2000	Transmitting Mag (4 segment)
NF 2	Pentode		Telefunken		200	
Raytheon 703A (American)	Possibly the 3B-24 which is a modernized version of the 705A. The 3B-24 is a high voltage rectifier.					
D 2 Ma (Obsolete)	Magnetron	18-26 cm.	Telefunken	Field 1330 G	2000	Receiver use

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TUBE NO.	TYPE	FREQ.	MFGR.	Mu	MAX. PLATE VOLTAGE	GERMAN TYPE SETS USING TUBE
RD 2 MH						Receiver tube
RD 12 TF	Triode					FuG 200 Hohentwiel
RG 62	Diode rect.		Telefunken		5500	
RL 2 4T4	Duo triode	Down to 3M	Telefunken	17	220	Transformer coupled audio amplifier
RL 4.8P15	Diode Pentode	Down to 3M.	Telefunken	Screen grid tube	400	In 15 WS Es-Trans-Rec. In N-27455 Transceiver (3000-7500 Kc.)
RL 12P 50	Pentode	Down to 2.5M.	Telefunken	Screen grid	1000	Power amplifier transmitting tube
RS 383	Pentode		Telefunken	330	1500	Transmitting tube amplifier
RS 393	Triode	UHF	Telefunken	16	2000	
RV 2.4P3	Pentode	Down to 3M.	Telefunken	(14/MA/V)	200	Power output pentode
RV2.4T3	(Space charge grid triode)	Audio	Telefunken	4.5	100	Transformer coupled amplifier
[illegible]4P [illegible]00	Pentode	HF	Telefunken	700	200	RF Amplifier
[illegible]12 H [illegible]300	Hexode	HF	Telefunken	Variable	200	Used as a variable Mu Mixer Stage
[illegible]00	Diode	UHF	Telefunken		100	Rectifier
[illegible]02	Diode	UHF	Telefunken		100	Rectifier
			Gema			Search receivers

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TUBE NO.	TYPE	FREQ.	MFGR.	Mu	MAX. PLATE VOLTAGE	GERMAN TYPE SETS USING TUBE
TS 6			Gema			Used in push pull "Freya II" in accessory unit "TU". All TS tubes are used in Freya. Seems to be a tuned push pull triode.
VH 3			Gema			42 G (Sub radar) supplies neg. voltage for grids.

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TAB J

DATA ON LAND ARMAMENTS

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Small arms:

7.92 mm MG 34:

Caliber	7.92 mm (0.312 in)
Weight with bipod	26½ lbs
with tripod	42 lbs
Action	Recoil-operated
Cyclic rate of fire	900 rpm
Effective range, as LMG	600-800 yds
as HMG	2000-2500 yds

7.92 mm MG 42:

Caliber	7.92 mm (0.312 in)
Weight with bipod	23 3/4 lbs
Cyclic rate of fire	1200-1400 rpm
Action	Recoil-operated
Effective range, as LMG	600-800 yds
as HMG	2000-2500 yds

Machine carbines (Maschinenpistolen):

	9 mm MP 40	7.92 mm MP 43/1 and 44
Caliber	9 mm	7.92 mm
Weight without magazine	9 lbs	11 lbs
Feed	32 round magazines	35-38 round magazine
Rate of fire, cyclic	500 rpm	(short bursts or
practical	180 rpm	(single-shot only
Ammunition	9 mm Parabellum	Special short rifle-caliber ammunition
Operation	Blow-back	Gas

Anti-aircraft guns:

88 mm AA guns:

a. 8.8 cm Flak 36 and 37:

Caliber	88 mm (3.46 in)
Weight in action	5.49 U.S. tons
Maximum ceiling	32,500 ft

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Maximum horizontal range		16,200 yds
MV: HE		2,690 ft/sec.
AP		2,600 ft/sec.
Weight of projectile:		
	HE	20 lbs
	AP	21 lbs

8.8 cm Flak 36 and 37 differ only in the data transmission system. No 8.8 cm Flak 38 has been identified.

b. 8.8 cm Flak 41:

Caliber		88 mm (3.46 in)
Weight in action		8.85 U.S. tons
Maximum ceiling		49,200 ft
Maximum horizontal range		21,580 yds
MV: HE		3,280 ft/sec.
Weight of projectile:		
	HE	20.68 lbs
	AP	22.45 lbs

105 mm AA gun:

10.5 cm Flak 38 and 39:

Caliber	105 mm (4.13 in)
Weight in action	11.03 U.S. tons
Maximum ceiling	36,750 ft
Effective ceiling	31,000 ft
Maximum horizontal range	19,100 yds
MV: HE (33.2 lbs)	2,890 ft/sec.

Kommandogerat 40 (AA Predictor (Amer. "director") 40)

This predictor (director) employs a 4-meter base stereoscopic range-finder mounted directly on it. Gun data is transmitted directly to the guns. It uses the linear speed method of data computation, and requires 5 men to operate it. It incorporates a mechanism which copes with changes in target altitude and target course (curvilinear flight). Can be used with different types of heavy AA guns by alteration of cams.

20 mm AA guns:

a. 2 cm Flak 38:

Caliber	20 mm (0.79 in)
Weight in action	896 lbs
Effective ceiling	3,500 ft

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Maximum horizontal range	5,230 yds
Rate of fire, practical	180-220 rpm
MV: HE	2950 ft/sec.
AP	2625 ft/sec.
Weight of projectile:	
HE	4.2 ozs
AP	5.2 ozs

b. 2 cm Flakzwilling 38:

Twin barrelled version of (a), having same performance.

c. 2 cm Flakvierling 38:

Four-barrelled version of (a), having same performance.

5 cm Flak 41 (50 mm automatic action AA gun)

Caliber	50 mm (1.97 in)
Weight in action	3.42 short tons
Effective ceiling	10,000 ft
Maximum horizontal range	14,760 yds
Practical rate of fire	130 rounds per minute
Muzzle velocity	2,755 ft per second
Traverse	360°
Elevation	-10° to +90°
Traction	4-wheel trailer, motordrawn
Projectile weight, HE	4.8 pounds

128 mm AA gun Model 40:

12.8 cm Flak 40:

Caliber	128 mm (5.04 in)
Weight in action	18.75 U.S. tons
Maximum ceiling	48,555 ft
Maximum horizontal range	22,910 yds
MV: HE	2,886 ft/sec.
Weight of projectile:	
HE	57 lbs
AP	58.13 lbs

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Flakvisier 38 (AA sight 38):

An electrically operated range-rate sight which computes lateral and vertical leads plus superelevation. The azimuth rate and elevation rate are measured through tachometer generators coupled to the guns traversing and elevating gears. Slant range is introduced as a battery voltage, modified by a rheostat, calibrated in hundreds of meters. In tracking, the reticles of the sight head are displaced by the battery voltage and tachometer voltage in such a manner that the gun is trained automatically on the future position.

This sight is normally used with the 2 cm Flak 38.

200 cm Flakscheinwerfer 40 (200 cm AA searchlight 40):

Candle-power	2,430,000,000
Lamp	High current density inverted arc

2.8 cm s.Pz.B.41 (28 mm Antitank gun 41):

Caliber (initial)	28 mm (1.1 in)
(emergent)	20 mm (0.78 in)
Length of barrel	5 ft 7.62 in
Weight in action	501 pounds
Muzzle velocity	4,600 ft/sec.

Guns, howitzers and rocket guns:

75 mm Recoilless gun:

7.5 cm LG 40:

Caliber	75 mm (2.95 in)
Weight in action	321 lbs
Maximum range	8,900 yds
MV: HE (12 lbs)	1,238 ft/sec.
Maximum traverse	360°
Maximum elevation	-15° to +42°
Traction	Airborne

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7.5 cm Pak 40:

Caliber	75 mm (2.95 in)
Weight in action	3,136 lbs
MV with HE (12.54 lbs)	1,800 ft/sec.
APCBC (15 lbs)	2,530 ft/sec.
AP40 (9.125 lbs)	3,250 ft/sec.
Traverse	65°
Elevation	-5° to $+22^{\circ}$
Traction	Motor-drawn
Armor penetration	With APCBC at 1,000 yds, 30° from normal--102 mm (4.02 in)

7.5 cm Pak 41:

Caliber, initial	75 mm (2.95 in)
emergent	55 mm (2.17 in)
Weight in action	3,136 lbs
MV: AP (5.68 lbs)	3,936 ft/sec.
Traverse	60°
Elevation	-10° to $+18^{\circ}$
Traction	Motor-drawn
Armor penetration	With AP at 1,000 yds at 30° from normal--130 mm (5.12 in)

150 mm Howitzer:

15 cm SFH 18:

Caliber	150 mm (5.866 in)
Weight in action	12,096 lbs
Maximum range	14,630 yds
MV (Charge 8)	1,705 ft/sec.
Traverse	60°
Elevation	-1° 30' to $+45^{\circ}$
Traction	Horse or tractor
Projectile weight (HE)	95.7 lbs.

240 mm Howitzer:

24 cm H 39:

Caliber	240 mm (9.4 in)
Weight in action	30.24 U.S. tons
Maximum range	19,700 yds

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MV	1,970 ft/sec.
Traverse	360°
Elevation	70°
Projectile weight (HE)	365 lbs
Mounting	Platform, static

Panzerfaust:

Consists of a hollow-charge antitank projectile launched from an expendable tube. The weapon is recoilless, the tube being open at the breech end.

The latest model, Panzerfaust 100, has the following characteristics:

Penetration of armor	200 mm
Range	Sighted to 150 meters
Weight	13½ lbs

Raketenpanzerbüchse 54 ("Panzerschreck")

A weapon similar in appearance to the American "Bazooka", used like it in an antitank role with a hollow-charge rocket projectile.

Maximum effective range	132 yds

15 cm Nebelwerfer 41:

Caliber	150 mm (5.9 in)
Weight	1,195 lbs
Maximum range,	
HE (75.3 lbs)	7,330 yds
Smoke (78 lbs)	7,550 yds

Six-barrelled equipment on 2-wheeled mounting with split trail.

21 cm Nebelwerfer 42:

Caliber	210 mm (8.27 in)
Maximum range	8,600 yds
Weight of rocket (HE)	248 lbs

Five-barrelled equipment on 2-wheeled mounting with split trail.

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28/32 cm Schweres Wurfgerät 41:

(1) HE 280 mm Rocket

Weight	184.5 lbs
Maximum range	2,100 yds

(2) Incendiary 320 mm Rocket

Weight	173 lbs
Maximum range	2,400 yds

30 cm Nebelwerfer 42:

A sextuple projector, similar to the 28/32 cm Nebelwerfer 41.

Weight of rocket (HE)	277 lbs
Maximum range	5,000 yds

15 cm Panzerwerfer 42:

A version of the 15 cm Nebelwerfer 41, having ten barrels, and mounted on an armored half-track vehicle.

7.3 cm Propagandawerfer:

A simple launcher of tubular steel, firing a 7.1 lb rocket containing 8 ozs of propaganda leaflets.

Ammunition and explosives:

Mortar shells 38 and 39:

8 cm WGr 38, 8 cm WGr 39:

These projectiles, known colloquially as "bouncing bombs" are outwardly identical and have only minor internal differences. A small charge in the head of the projectile explodes instantaneously, throwing the rest of the shell into the air, where it bursts after a small delay, giving an air-burst effect. These shells had been discarded by the middle of 1944, being by then considered not worth the trouble. Projectile weight is 7 3/4 lbs.

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Hexogen (Also called Cyclonite, T4, or RDX):

Cyclotrimethylenetrinitramine, a very powerful high explosive.

Diethyleneglycoldinitrate (DEGN):

This is used, in conjunction with nitro-cellulose, in a frequently encountered German double-base propellant.

Vehicles:

Tanks:

	Pz.Kpfw III	Pz.Kpfw IV
Weight in action	24.6 U.S. tons	26 U.S. tons
Crew	5	5
Armor, maximum	57 mm	60 mm
Armament	1 - 5 cm Kwk 39 2 - MGs	1 - 7.5 cm Kwk 40 2 - MGs
Dimensions:		
length	17 ft 8 in	19 ft 4 in
width	9 ft 9 in	9 ft 7 in
height	8 ft 3 in	8 ft 6 in
Maximum speed	35 mph	25 mph
Engine	Petrol, 296 HP at 3,000 rpm	V-12, petrol, 295 HP at 3,000 rpm

Panther:

Weight in action	50 U.S. tons
Crew	5
Armor, maximum	110 mm
Armament	1 - 7.5 cm KwK 42 2 - MGs
Dimensions:	
length (excluding gun)	21 ft 11½ in
width	10 ft 9¼ in
height	9 ft 4 in
Maximum speed	35 mph
Engine	Petrol, V-12, 690 HP at 3,000 rpm

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Tiger:

	Model E	Model B (Royal Tiger)
Weight in action	62.75 U.S. tons	75 U.S. tons
Crew	5	5
Armor, maximum	102 mm	180 mm
Armament	1 - 8.8 cm KwK 36 2 - MGs	1 - 8.8 cm KwK 43 2 - MGs
Dimensions:		
length (excluding gun)	20 ft 8½ in	23 ft 10 in
width	12 ft 3 in	11 ft 11¼ in
height	9 ft 4 3/4 in	10 ft 2 in
Maximum speed	25 mph	26 mph
Engine	V-12, petrol, 6[illegible]0 HP at 3,000 rpm	V-12, petrol, 590 HP at 2,600 rpm

Armored cars:

Four-wheeled:

Weight in action		5.25 U.S. tons
Crew		3
Dimensions:	length	15 ft 7 in
	width	6 ft 3[illegible] in
	height	5 ft 11½ in
Armor		8 mm
Armament		1 - 20 mm machine cannon 1 - MG

Eight-wheeled:

Weight in action		8.35 U.S. tons
Crew		4
Dimensions:	length	19 ft 1 in
	width	7 ft 3 in
	height	7 ft 10 in
Armor		8-15 mm
Armament		1 - 20 mm machine cannon 1 - MG
Engine		8-cylinder, 155 BHP, Petrol.

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TAB K

MATERIEL PASSING THROUGH RUSSIA TO THE FAR EAST PRIOR TO 22 JUNE 1941

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Materiel Moving through Soviet Russia
to and from Europe and the Far East

Prior to the outbreak of hostilities between Germany and Soviet Russia a large volume of material was moved from Germany to the Far East (Japan, China, Manchuria and Korea) by trans-Siberian railway. During the period June 1940 to May 1941 the following transfers were recorded but it is considered probable that traffic in excess of the volume noted did in fact reach destination. Exact detail of the material is not available, but it is clear that the Japanese had planned purchase of heavy industrial equipment, armaments, machine tools, prototype and special materials, in Europe and to move such material overland, thereby avoiding the British blockade of sea routes.

Complementing Japanese purchases in Europe, a large volume of material, mainly raw products, was transferred to Germany from Japan, Manchuria and China also by trans-Siberian railway, and it is of interest to note that recorded movements in the first five months of 1941 greatly exceeded tonnages in the whole of 1940.

With the outbreak of war between Germany and Soviet Russia all transfers of goods in any volume were confined to surface blockade runners and, subsequently, to submarines.

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Commodity	Quantity
1. Army, Naval and Marine Equipment.	
Machinery for Mukden Arsenal	72 carloads
Equipment for Manchukuo Army	59 "
Ammunition	8 trainloads
M.A.N. Caterpillar trucks	30 vehicles
Lantz " "	20 "
Naptha tractors of Artillery type	50 "
High Speed artillery tractors	40 "
Optical accessories & lathes for Arsenals in Manchuria	3 carloads
Armour steel	900 tons
Parts and accessories for Japanese Navy	93 carloads
Motor torpedo boats	15 boats
Portions of small torpedo boats	
Technical, optical and other material for Naval purposes	150 carloads
Marine engines 50-500 H.P. (for fishing craft?)	25 engines
Marine engines for fishing boats	65 "
2. Aeroplanes and Aircraft Production.	
Heinkel 111's	5 aircraft
Junkers 88's	10 "
Messerschmitts 109 fighter bombers	10 "
1,000 H.P. Jumo Aircraft engines	60 engines
Daimler-Benz Aircraft engines	70 pieces
Junkers Aircraft engines	50 pieces
Bosch magnetos for aircraft	5 cases
Aircraft factory machine lathes	72 carloads
Machinery for Aircraft Factory	
3. Machine Tools, and General Engineering	
Machine tools and accessories	Rm.4,500
Tools	230 cases
Tube rolling equipment	105 carloads
Lathes and machinery	15 carloads
Schmidt Offenbach lathes	1 trainload
Machines for manufacturing high speed Fay lathes for drilling motor cylinders	72 machines
High Speed Drills	511 pieces
Engineering gauges & other engineering materials	120 cases
Wrenches	948 pieces

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Commodity	Quantity
Machine Tools, and General Engineering - cont.	
Hacksaw blades	220 gross
Arcos Iron Welding Rods	300 tons
Machinery for distillation and steel plants at Anshan	240 carloads
Spare rolls for blooming mills	236 rolls
Blast furnace equipment	114 carloads
Poldhutte Shear Steel "A" Quality	50 tons
4. Oil Plant	
Specially large and complete plant for processing casing head gasoline to natural gasoline comprising 10 sets of 4 machines each, and including compressors for 200 atmospheres taking 600 H.P.	
Equipment for gasoline, coke chemical (?distillation) works	40 carloads
Rotor drills for deep drilling	5 sets
Machinery for processing gas to gasoline	3 sets
Crude oil refining machinery	130 carloads.
5. Mining Equipment etc.	
A. Most modern coal cutting machinery	10 sets
Mining machinery (deep drills) for Kirin Province	5 carloads
B. Coal Distillation Plant	72 carloads
Equipment for coke producing plant for Peking	72 "
6. Hydro-Electric Plant.	
Parts and accessories for Hydro-electric plant on Yalu River	80 carloads
Machinery and parts for Yalu River Hydro-Electric Plant	478 "
Machinery for Kirin Electric Station	35 "
Hydro-Electric Plant	91 "

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Commodity	
7. Vehicles - Parts etc.	
A. Large oil driven grabs	2 vehicles
2 ton trucks	60 "
Agricultural tractors	100 "
Goods locomotives (Mikado 141)	30 "
Locomotives	5 "
Skoda locomotives	5 "
B. Magnetos	18 cases
Bosch Magnetos	300 "
8. Miscellaneous Plant etc.	
Equipment for bean oil refinery	30 carloads
Soya bean oil extracting equipment	114 "
Sulphuric acid producing equipment for S. Manchuria	140 carloads

SUNGARI RIVER HYDRO-ELECTRIC PROJECT.

Reliable information has been received that four 100,000 kilowatt hydro-turbines, which were being built for the Japanese by Siemens-Schuckert, were not despatched via Siberia before this route was closed.

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